CHEMISTRY

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WINNERS IN CHEMISTRY, PHYSICS AND MEDICINE

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Editorial:
Bridging the Gap
Inside Front Cover

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Bridging the Gap

➤ THERE IS, and has been for some years, an obvious gap between science as it is taught and the newer developments stemming from modern research. This gap is, in general, much wider at the high-school teaching level than at the university level, where many teachers are also engaged in active research. This problem is well recognized, and the purpose of this publication is, at least in part, to bridge this gap.

How can there be secured for secondary schools teachers who have the research viewpoint? A college student, pondering on this problem, has made the following suggestion that we now pass on to our readers.

The premise is that *most* research scientists are most inventive before reaching their late forties. After this their minds become less receptive to new ideas and less flexible; they become less productive. Not all will agree to this, especially the older and more mature scientists themselves.

We have then a reservoir of men with scientific experience and perhaps ten or fifteen years before retirement. They could be applied to the over-all shortage of well-qualified science teachers, helping to close the gap between textbook and research laboratory. Rather than "waste" creative young scientific minds in teaching, let their place be taken by the experienced ex-research men, thus providing more young scientists, less scientific stagnation through faster promotions, and more experienced science teachers.

In practice there would be many problems, chief of which is the question of large salary differences. There is also the insistance by education systems that teachers have a teacher's certificate, that teachers be formally trained in *how* to teach rather than in *what* to teach.

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1959 Nobel Winners

Chemistry

➤ THE INVENTION and development of one of the foremost methods of chemical analysis by instruments won the 1959 Nobel Prize in Chemistry for Prof. Jaroslav Heyrovsky of Charles University, Prague, Czechoslovakia.

The polarographic method of analysis depends on the different speeds with which ions travel in solution under the influence of an electric field, and the ease with which atoms part with their electrons to form ions.

It is used extensively in chemical laboratories around the world both in industry and for research. The method is particularly valuable in the field of metallurgy.

Its advantages include easily reproducible results and ability to show the presence of chemicals present only in very small amounts. Other outstanding features of the method are its rapidity of operation, the possibility of analyzing solutions the size of a drop, the fact that in most cases the solution remains unaltered during the analysis and can later be used for other purposes, and the recording of results automatically on a graph to provide a permanent record of the analysis.

The method also gives simultaneous quantitative and qualitative analysis of several components of a solution.

The first polarograph was constructed in 1925, and resulted from Prof. Heyrovsky's studies of electrolyses with a dropping mercury cathode. Electrolysis is the passage of an electric current through a solution, resulting in the movement of ions to positive and negative electrodes.

The polarographic method may be defined as a method of analysis based on the electrolysis of a minute fraction of a solution in a cell consisting of one small, easily polarizable, and one large, non-polarizable electrode.

(In electrolysis, polarization is the increase of the resistance of a solution due to gas accumulation at the electrode or chemical depletion in part of the solution.)

The voltage necessary for the electrolysis indicates the nature of the reacting substance, while the current observed indicates its concentration.

Physics

➤ THE 1959 Nobel Prize in Physics was awarded to two scientists who deal with the strange world of the atomic nucleus.

Drs. Emilio Segre and Owen Chamberlain of the University of California led the Radiation Laboratory team that discovered the anti-proton in 1955 using the bevatron, a powerful atom smasher. Dr. Chamberlain is now a visiting professor at Harvard University.

The anti-proton, or negative proton, is one of a group of subatomic particles having properties opposite to those of ordinary matter. One outstanding property of anti-matter particles is that when they come close to

ordinary protons or neutrons, the two annihilate each other, releasing a large amount of energy.

The energy released in annihilation is several hundred times that in the corresponding reaction in hydrogen thermonuclear fision.

Anti-protons are born and "live" only outside the nucleus following some high energy nuclear event similar to the collision resulting from bevatron bombardment, when the anti-matter particle is created from energy.

Two astronomers have suggested that clashes of matter with anti-matter, destroying both, could cause the broadcasting of radio waves from space picked up on earth by the great antennas called radio telescopes. They calculated that the most anti-matter that could be present in the Milky Way galaxy in which the sun and its planets, including earth, are found is one part in 10,000,000.

Physicists have for several years known about the anti-particles of pi mesons, the glue that keeps atomic cores from flying apart. However, for the very rare hyperons, only one anti-particle has so far been found, the negative lambda.

Hyperons are unstable particles from the atomic nucleus, heavier than the proton or neutron. They live for only billionths of a second, but during that fleeting lifetime their existence is just as real as that of a neutron, which lasts for about 12 minutes before decaying into a proton.

One question puzzling physicists, therefore, is exactly what are fundamental particles. Neutrons and protons, both found in the nuclei of atoms, are fundamental, physicists agree. They are still debating where to draw the line, however, since the number of strange fragments found in the debris of smash-ups between atoms is bewildering. Some 30 particles are now known or expected to be found.

The anti-particles of hyperons still to be discovered include one each for the three kinds of sigmas known and one for the negative xi.

Medicine

➤ Dr. Arthur Kornberg, 41, shares the Nobel Prize in Medicine and a cash award of $42,610 with Spanish-born Dr. Severo Ochoa, 54, chairman of the biochemistry department of New York University College of Medicine in New York.

The award was presented for their joint work at the New York college in the middle 1940's. At that time they successfully synthesized nucleic acid. This acid is found in the cells of all animals, plants and bacteria. The discovery involves the materials that are believed to determine the nature of offspring of these forms of life.

Currently, Dr. Kornberg is working on the biosynthesis of DNA, deoxyribonucleic acid, an essential component of living cells. Dr. Kornberg, now chief of the biochemistry department at Stanford University, Palo Alto, Calif., has successfully isolated the enzyme that, coupled with a primer and what he termed "building blocks of the body," can produce DNA in the test tube.

The material that Dr. Kornberg produced in the test tube is identical with the DNA of animals, bacteria, plants, and viruses. The DNA is a

complicated molecule that is believed to act as the "code" or pattern in determining genetic characteristics.

Dr. Ochoa has worked in the field of enzymes. He has studied the reactions between inorganic and high energy phosphate, leading to the discovery of the enzymatic synthesis of RNA, ribonucleic acid.

RNA is the energy-packed cell machinery that manufactures protein. RNA is also found in the genes of cells in another form, DNA, and holds the secret of heredity.

Such molecules that have been produced in the laboratory appear to be identical to nature's. They behave alike in many ways but it is still not certain whether these molecules are exactly as nature makes them or not.

√ *Chemistry Quiz* √

Directions: Mark the answer you think *most nearly correct.*

Answers are on page 13.

A. In terms of quantity of metal in the earth's crust, what is the rank of titanium?

1. fourth
2. second
3. tenth
4. twentieth

B. In which way is soil fertility most affected by the atmosphere?

1. nitrogen sifting onto the ground
2. phosphates blown by the wind
3. redistribution of "trace" elements
4. spores deposited by the wind

C. Fluorides are added to drinking water in order to

1. improve fertility
2. increase metabolism
3. prevent typhoid fever
4. reduces caries

D. From which of the following has synthetic wool *not* been made?

1. corn cobs
2. egg albumin
3. milk
4. peanuts

E. The hottest flame as yet produced by man has been made by using

1. fluorine and hydrogen
2. hydrogen and oxygen
3. oxygen and acetylene
4. oxygen and aluminum

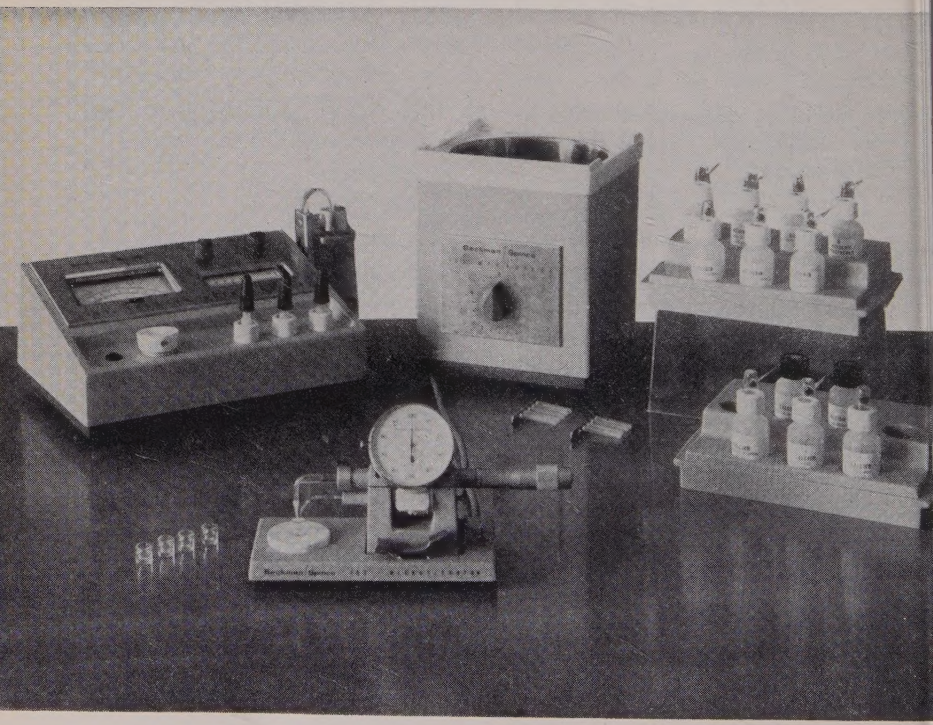
Complete copies (with answers and norms) of many previous Science Talent Search examinations are available at 15c each from Science Service, 1719 N St., N.W., Washington 6, D. C.

New Ultramicro Analytical System

➤ A NEW SYSTEM of equipment which greatly simplifies analyses of sub-miniature chemical samples is announced by the Spinco Division of Beckman Instruments, Inc., Palo Alto, California. The System is expected to find its widest application in clinical laboratories since it makes possible routine analyses on less than a drop of blood.

Basis for the Beckman/Spinco Ultramicro System is a new method for accurately measuring and dispensing minute volumes of liquid. Liquid reagents are contained in a series of small squeeze bottles, each bottle fitted with a calibrated polyethylene tip which serves as a pipette. During analysis, the precise amount of reagent is added simply by squeezing the bottle.

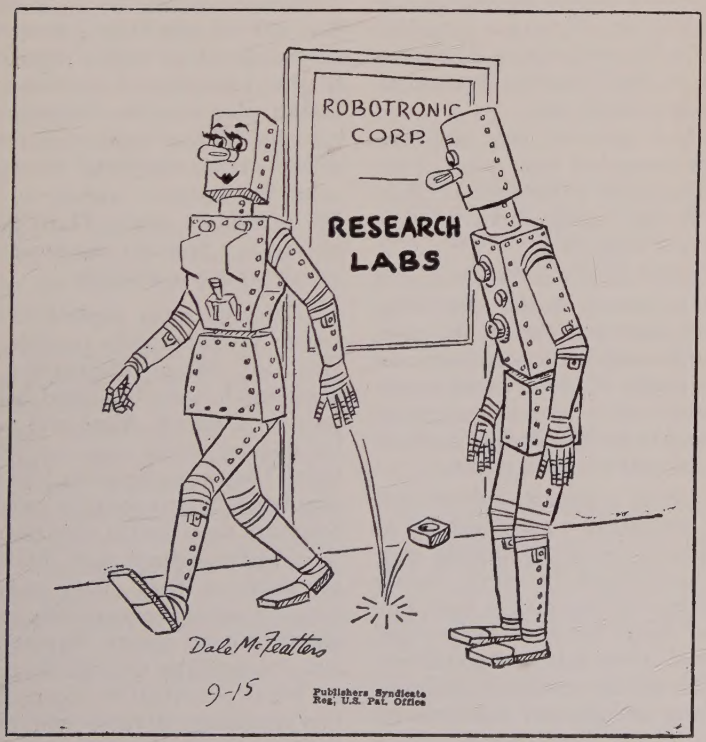
The complete Ultramicro System consists of a miniature Spectro-Colorimeter with a flushing sample cell for colorimetric procedures, a Micro-Titrator with built-in stirrer for titrations, a Microfuge for centrifuging blood samples, and ten Micropaks. Each Micropak contains all reagents required for a particular clinical test, and additional Micropaks can easily be added to the system. Components of the system are unbreakable and require no washing.



The procedures and instruments are simple for any technician to use, thus extending ultramicro analysis into even the smallest clinical and hospital laboratories. In actual laboratory use, the procedures have proved both faster and more accurate than conventional methods.

The use of ultramicro samples means that now sufficient blood for complete chemistries can be taken from the finger or heel without having to puncture veins. This is of special interest in pediatrics, geriatrics, and special clinical cases.

Small samples are also of great importance in such fields as small animal research, pharmacology, nutritional studies, criminology, and radiation chemistry.



Feeding the Spaceman

➤ THE MAIN BARRIER to man's reaching other planets may not be heat or weightlessness or inadequate thrust—it may be a question of food, according to the *Journal of Agricultural and Food Chemistry*.

A round trip to Mars, with conventional feeding methods, would require tons of food, water and oxygen for each member of a space crew, since the trip would take at least two or three years, according to the American Chemical Society monthly. Because each ton of cargo requires roughly a thousand tons of thrust, this weight of food becomes unmanageable, it is pointed out.

The food question, less publicized and less researched than some of the more glamorous problems of space travel, is also further from solution, the journal observes.

A possible answer is the creation of a cycle of nature in the space ship, in which man is a part of the cycle, says the journal. It cites a report from the University of Texas based on experiments with common algae, or sea weed, said to be "the leading contender" to join man in such a cycle.

Jack Myers, a botanist and zoologist at the university, reports that 2.5 to 5 pounds of the alga *Chlorella pyrenoidosa* can absorb the carbon dioxide exhaled by one man and, in turn, provide his needs for both oxygen and food, with some minor supplementation. This can be contained indefinitely as long as light and nutrients are supplied to the algae, he says.

"Algae are potentially a nourishing food," says the *Journal of Agricultural and Food Chemistry*. "They contain roughly 50% protein, 15% carbohydrate, 25% fat, and 10% ash. These percentages vary, of course. Some B vitamins, carotene, and ascorbic acid also are present. True, some essential nutrients are lacking, but since such a high percentage of algae is digestible and since some species can double their weight 12 times in a day, they are almost certain to be on the menu for long space trips.

"What nutrients do algae need to flourish? Mostly they are the same ones required by higher plants — nitrogen, phosphorus, potassium, and carbon, plus some trace elements. Fortunately, human wastes contain most of the needed elements. Nitrogen as urea, for instance, makes up about 50% of urinary solids. Thus, a useful as well as a practical means of disposing of wastes is available.

"Although using algae in a closed system is theoretically possible, there are many difficult engineering problems which must be solved before it becomes a reality. Algae will need illumination, using solar or artificial light. They must be aerated and their population density must be controlled. Scientists must find a way to harvest them and transmute them into a form acceptable as food. They must also design a miniature processing plant to handle human wastes. Another problem: controlling the cellulose build-up which is certain to occur. To further complicate all these requirements, there is the all-important weight limitation, plus the fact that the system must operate in the zero-gravity state.

"There are two very strong objections to the use of algae as food for the spaceman. The first concerns the one-food diet aspect; the other concerns algae's aesthetic values — flavor, odor, textural quality — or lack of them.

"Lack of variety is a big drawback. How long a man can stand an unvaried diet is the subject of much debate, but it has been hinted that even the best steak becomes tiresome after three days if that's all there is to eat. And who dares classify algaeburgers with steak?

"This factor becomes very important in long space flights because food will be man's chief link to the world as he knows it. He will be subject to many physical and physiological stresses. If his food is not what he is used to, it becomes an additional stress.

Added to his other problems, his antipathy toward a monotonous diet may be the straw that breaks the astronaut's back.

"On top of all this is the knowledge that he is eating his own wastes, with but a few steps in between. This psychological factor may be enough to discourage even the most dedicated space traveler. Scientists at the USAF School of Aviation Medicine, Randolph Field, have recently suggested a way to circumvent this. They advocate putting some kind of animal into the closed system. The animal could eat the algae and the man could eat the animal — in a form more agreeable to him.

But another expert points out that this added step could raise the overall cost of the system by a factor of at least 5, since production of a pound of animal requires 5 to 10 pounds of food.

Most estimates have it that a closed system will not become practical for at least 10 years, although some are willing to gamble on five years. Most agree, however, that it won't be needed for 10 years because other food forms will satisfy the needs of short space flights.

When it does come, the closed system probably will not be the astronaut's sole source of food. Rather, it will provide a supplement to his diet. A partial balance has been suggested. Water and oxygen could be recovered from wastes and recycled. Food could be transported. Solid wastes would be stored in the space vacated by the food as it is used.

Still another possibility is chemical synthesis of at least part of the food, and chemical reduction of the carbon dioxide waste to carbon and oxygen.

"The variety of opinions on almost every aspect of space feeding suggests one conclusion: a practical solution to the problem is still a long way off. Research must be increased significantly if a feasible closed system is to be developed, even in 10 years.

According to Robert G. Tischer of Mississippi State University, there are only about a dozen laboratories in the U. S. actively working on the problem. Another observer puts it this way:

" 'The problem will be licked as soon as any agency, government or otherwise, spends $5 to $10 million a year on it for at least three to five years, probably ten.' "

New Chemical Patents

To obtain copies of these new patents, order them by number from the Commissioner of Patents, Washington 25, D. C. Enclose 25 cents in coin, money order or Patent Office Coupons (but not stamps) for each patent ordered.

Device Measures Borehole Pressures

➤ A DEVICE for measuring the pressure in a borehole has been granted patent No. 2,906,120, and assigned to the Jersey Production Research Company, Houston, Texas.

When drilling for oil, it is desirable to obtain quick, continuous knowledge of pressures within the borehole to prevent wasteful and dangerous "blowouts" if a high-pressure zone is pierced by the drilling bit.

Existing pressure-measuring devices using temperature-sensitive force elements against which the pressure is to be balanced, are hampered by the wide range of ambient temperatures encountered in boreholes. Also, when too complex or fragile, the pressure, measuring devices are unsuited for earth drilling operations because of the rough treatment they must take.

This new device, invented by Henry M. Buck, also of Houston, is claimed to be simple, rugged, not sensitive to temperature, and able to provide at a remote location a continuous record of the pressure measured.

With this device, the pressure to be measured is balanced against a force not subject to variations — an oppositely directed force derived from a rotating flyball assembly.

Essentially, by measuring the speed of rotation of this assembly, the magnitude of the pressure can be very exactly determined.

Bacteria Extract Oil From Sands and Shale

➤ BACTERIA are used to extract oil from oil-bearing sands and shales in a new recovery process.

The process earned for Donald O. Hitzman of Bartlesville, Okla., patent No. 2,907,389. It was assigned to the Phillips Petroleum Company.

Recovery of oil from such inorganic solids has always been a problem because of the close association of the oil with the sand or shale and the necessity of handling large quantities of the solids. Previous processes, including destructive distillation, solvent extraction, and hydrogenation at high temperatures and pressures in the presence of a catalyst, have not satisfactorily overcome these problems and give relatively low yields, Mr. Hitzman believes.

His "improved" process uses a combination of hydraulic mining and bacteria in the presence of oxygen. The mechanism by which bacteria displace oil from solids is not clearly understood, he says, but certain aerobic bacteria have been found to be very adept at it. This is how his process works:

The oil sand or shale is mined by the hydraulic action of water so that the material is slurried in the water. Then it is washed to an aerated accumulating zone, such as a pond

Bacteria placed in the pond grow in the presence of oxygen and act to release oil from the sand or shale. When a sufficient amount of oil has been released, the sand becomes water wet and sinks to the bottom. The oil left floating on the surface is recovered, usually by a skimming operation.

The water from the pond may be recycled for additional mining and slurrying because it contains active bacteria that aid in loosening the oil from the soil during the hydraulic mining operation.

Coating Protects Aluminum

➤ A WAY to speed the manufacture of prefabricated aluminum parts won patent No. 2,901,821 for Wilford H. Ross, Jr., Detroit. He assigned his patent rights to Detrex Chemical Industries, Inc., Detroit.

Mr. Ross invented a way of coating metallic aluminum with an aluminum benzoate film to protect it from oxidation. Oxidized aluminum must be cleaned before welding, otherwise electrical resistance is uneven and the weld may not be perfect.

Various cleaners now available sometimes attack the aluminum metal itself, or leave other films which are as electrically resistant as the original oxidation. Some are hazardous to handle, some "alloy" the weld undesirably, and some require special, expensive equipment such as corrosion-resistant tanks. Mr. Ross said the aluminum benzoate treatment is designed to overcome those drawbacks.

New Plastic Explosive

➤ WARREN H. ECKELS of Kingston, N. Y., has invented a sort of plastic dynamite that can be prepared in a solid or gelatinous form. The explosive consists of nitric esters, nitrocellulose, nitro-starch, crystalline explosives and a silicone gel. The explosive has "greatly increased storage stability," and "does not undergo an unappreciable change in physical characteristics after extended storage at either high or low temperatures," Mr. Eckels stated. He assigned patent No. 2,902,355 to Hercules Powder Company, Wilmington, Del.

Array of Background Smells Is Offered Movie Audiences

➤ MOVIE AUDIENCES may be offered smells to match the action on the screen as a result of an apparatus recently granted a patent.

The apparatus distributes odors in timed sequence with respect to a motion picture film. It will permit the film editor or producer to select odor sequences suited to the action on the film in the same manner they choose background music.

The machine consists mainly of a series of 46 scent-containing cells situated on a belt wound on a reel. As the belt moves in synchronization with film action, each successive cell, containing the appropriate odor for the scene, comes in contact with a pump and blower system that distributes the smell effectively throughout a viewing area about 100 feet long, 45 feet wide and 40 feet deep.

Hans Laube of New York City says each odor will be emitted for about seven seconds. He believes this length of time will create a psychological effect on the audience of a continuing odor as long as a particular scene lasts. If the scene is extra long, however, several successive cells can contain the same odor.

Mr. Laube thinks 12 to 20 different

odors for a full-length film is sufficient and that intervening periods of no smell add to the effectiveness of each new smell. He assigned 15% of the rights to patent No. 2,905,049 to Len Ruskin, Frank B. Carbone and Bernard V. Sturz, and 85% to Bert Good and Hans Laube, all of New York City.

Blue, Ivory, Green Bricks Made by New Process

➤ FUTURE HOUSES and offices may be made of bright-colored bricks that never need painting.

Harley B. Foster of Greensboro, N. C., was awarded a patent for his methods of changing the natural color of bricks, tile and other ceramics.

In experiments, Mr. Foster found that applications of zinc oxide, and small amounts of manganese dioxide, to unfired bricks produced unusual final colors, depending on what other metal was added as a colorant. Addition of copper makes cream, ivory and buff. Cobalt makes blue; chrome makes tan-green; nickel makes silver-gray.

The final color becomes part of the brick physically and chemically and thus resists flaking off under freeze-thaw weather conditions.

His process is based on application of a metallic compound which "marries" iron in the clay, under heat, to form light-colored crystals. As these crystals form, the low-cost pigments diffuse into them to impart the final color. The invention won patent No. 2,902,739.

Improved Titanium Forging

➤ PURE TITANIUM and alloys containing at least 80% titanium may be forged without the fear of forming contaminated surface layers of brittl oxygen-nitrogen compounds as a re sult of a new method for hot work ing this important metal.

Invented by Dean K. Hanink, In dianapolis, Ind., and James C. Holz warth, Birmingham, Mich., the pro cess also protects the titanium article during forging at high temperature so as to reduce the amount of ma chining subsequently required and t permit forging to closer dimensions.

Titanium objects, such as turbine blades for gas turbine engines, ofte have to be forged to obtain certain desirable physical properties.

During the heat cycles which must be used in such forging, oxygen and nitrogen are absorbed at the surface of the titanium.

This surface contamination during the metal's machinability.

Diffusion of oxygen and nitrogen into the metal also makes the titanium very brittle because these elements form stable compounds with the ti tanium.

The new hot working process, which received patent No. 2,903,785 and was assigned to the General Mo tors Corporation, Detroit, Mich., involves applying a protective coating of aluminum on the titanium to be forged, or otherwise hot worked, before it is heated to working temperature. This prevents formation of surface contamination during the forging operation.

The protective nature of the aluminum coating is retained during multiple heating and forging. Furthermore, the coating does not interfere with the flow of titanium during hot working.

Glycerin: Versatile By-product

by Burton L. Hawk

➤ When fats, greases, and tallows are saponified by reacting them with alkali, they are "split" and two important products are obtained: soap and glycerin. We assume (and we hope) that you are familiar with the action of the former product. Soap has always been considered the main product and glycerin the by-product. However, during the last decade or so, the commercial demand for glycerin has been steadily increasing. Even the production of synthetic glycerin, which is now readily available, has not satisfied the demand. With the advent of synthetic detergents, maybe someday fats will be split to obtain the glycerin, and soap will be the by-product!

Common Uses

The commercial use of glycerin varies from hand lotions to dynamite. But, in keeping within our scope, we will confine our interests to the use of this product around the home.

Men! Does your hammer-head keep coming off the handle? Simply immerse the top of the handle in a glycerin solution. This will cause the wood to swell and prevent it from drying out and contracting.

When you paint doors or windows, apply glycerin to the doorknobs, locks, and other hardware. This will protect the metal from paint spotting and is very easily removed after you are finished.

Perhaps you are familiar with the windshield treatment for your car to prevent fogging of the glass. Wipe the inside of your windshield with a cloth dampened with glycerin. This will stop the annoying steaming and fogging of the windshield. In the winter, the outside of the windshield can be wiped with a solution of glycerin in water (about 60 parts glycerin to 40 parts water) to keep frost from forming. Or, for you folks with all the modern accessories on your car, place the glycerin solution in your windshield-wiper spray container.

Ladies! Does your cake icing become brittle and hard after a short while? Just add a teaspoon or two of glycerin to your regular recipe. This will help keep it smooth and prevent drying out.

Or, would you like to cook faster? Eggs boiled in a solution of 6 parts glycerin and 4 parts water will be done in about one-half the normal time. If you use a double boiler, cook foods *over* (not in) the glycerin solution. Again, they will be done in half time. Foods, such as tart fruits, that you want to sweeten may be cooked right in the glycerin solution. Glycerin will help make the foods sweeter.

Do you like to see bright and shiny fruit in your fruit bowl? After washing and wiping the fruit, rub it with a cloth dampened with glycerin solution (add two teaspoonfuls of glycerin to half cup of water). The fruit will retain a brighter, more luscious-looking appearance. And when you eat it, the glycerin will help sweeten it.

Sometimes during the ironing of nylon and other synthetic fabrics, melted deposits tend to form on the bottom of the iron. Extreme care must be taken in removing the deposit so that the iron is not scratched. Moisten scouring powder with glycerin and apply to the iron while warm. This will enable the deposit to be removed without scratching.

Washable gloves often tend to become hard and stiff upon drying. Adding a teaspoonful of glycerin to each pint of rinse water after washing will help to maintain softness. The same treatment applied to woolen socks and mittens will help lessen "scratchiness."

Does your modeling clay cake and dry out? Just add a few drops of glycerin and work it into the clay. This will help keep it soft and flexible.

Do your soap bubbles burst too easily? You can make tougher bubbles by dissolving 1 oz. of pure soap flakes in 8 oz. of water. Then add 4 oz. of glycerin and stir thoroughly and allow to stand. A clear liquid will form at the bottom. Very carefully pour off the liquid on top and use the clear liquid to blow your bubbles.

Glycerin Cement

Mixed with litharge, glycerin forms a strong cement which can be used for sealing pipe joints, setting tile, repairing leaks in pipes, boilers, and filling cracks in cement, stone, etc. To prepare it use a 75% solution of glycerin (75% glycerin mixed with 25% water). For every 4 oz. of litharge (for you chemists: this is lead monoxide or lead oxide, yellow), use about 1½ fluid ozs. of the glycerin solution. Mix the ingredients thoroughly. Prepare only as needed as setting time is very rapid.

Removing Stains

Glycerin is very often helpful in removing stubborn stains such as ink, coffee, fruit and food, from rugs and clothing. Rub glycerin into the stain and allow to stand overnight. The glycerin will loosen the stain and allow it to be removed easily by flushing out with warm soapy water.

For milk stains, rub the stain thoroughly in a solution of one part glycerin and three parts warm water. Allow to stand for about twenty minutes, then rinse.

For grass stains, make up a mixture of equal parts glycerin and egg white. Soak the stain in this solution for several hours. Then rinse with mild soap and water.

Rust stains in concrete are usually very difficult to remove. You might try this method, which usually works. Dissolve one part of sodium citrate in six parts of water and add an equal volume of glycerin. Now, using this solution, prepare a paste by mixing it with powdered whiting (for you chemists: this is calcium carbonate, prepared). Using a putty knife, spread the paste on the stain. Allow to dry thoroughly, which may take several days. Then remove the paste. If the stain is not entirely removed, it may be necessary to re-apply the paste several times.

Removing Scratches from Glass

Make up a paste by thoroughly mixing together glycerin, water and rouge (for you chemists: this is ferric oxide, or iron oxide, red). Using a felt pad, rub the scratches with this

paste until they disappear. Remove the paste by washing with water (for you chemists: this is H_2O).

Preserving Foliage

Leaves and foliage can be preserved by placing specimens in a 50-50 glycerin water mixture for about two to three weeks. Also, your Christmas evergreens and holly will keep longer if wiped with a 20% solution of glycerin in water.

Translucent Window Paint

If you want privacy and light too, try painting your windows with this paint. Mix thoroughly 5 parts of methyl cellulose with 30 parts of water. Then add 5 parts of wet ground mica and 2 parts glycerin. Thin with water to the desired opacity. Simply, brush the paint on the window. To remove, just wash with water.

Tire Preservative

After washing, wipe the sides of the tires with glycerin solution. This will prevent cracking if done regularly. This treatment is also applicable to other items made of rubber.

In Home Pharmaceuticals

Glycerin is handy to have in the medicine chest. It will soften the accumulation of wax in the ears. Also, cotton soaked in warm glycerin placed in the ear will help relieve the pain of simple earaches.

As an enema, glycerin may be used mixed with equal parts of water. One to three ounces of the solution is injected.

Glycerin is well known as a skin lotion. Mixed with equal parts of rose water, it is a good remedy for chapping, scaling and dryness.

An after-shave lotion can be made by mixing together 30 parts of liquid extract of witch hazel, 20 parts of alcohol, 10 parts of glycerin, and 40 parts of rose water.

For a non-oily hair dressing, mix together 40% glycerin, 40% alcohol and 20% water.

If you use rubbing alcohol as a skin freshener, your skin will like it better if a small amount (about ¼ the volume) of glycerin is added to the alcohol.

Crusts, calluses and scabs on the skin can be softened by treating with glycerin. Use a piece of cotton soaked in glycerin; apply at bedtime. For stubborn cases, apply the glycerin, then cover with bandages overnight.

Use glycerin as a lubricant for hypodermic syringes, rectal thermometers, etc.

In Closing

So, we conclude the case for glycerin. It's handy to have around. And, also you will help to make the glycerin producers happy. And, finally, we are indebted to the Glycerin Producers' Association for some of the information outlined here.

√ Answers to CHEMISTRY QUIZ on page 3. √

A - 1; B - 1; C - 4; D - 1; E - 1.

Boston Coed Top Freshman Chemist

➤ A SOPHOMORE coed at Boston University's College of Liberal Arts, Cecilia Clapp of 10 Winsor Avenue, Watertown, Mass., has been named "first in New England" in a nationwide competition for 1958-59 college freshman chemistry students.

The competition, in which 1100 institutions participate nationally, is sponsored annually by the Chemical Rubber Publishing Co., publishers of "Handbook of Chemistry and Physics," and is open to all colleges and universities in the United States.

The top freshman chemistry student in each of 1100 schools during the 1958-59 academic year was rated on the basis of a competitive examination and a winner was named for each of six regions in the country.

Miss Clapp, a native of Boston, was chosen winner among contestants representing more than 80 New England colleges and universities. A graduate of the Cambridge School of Weston (Mass.), she also attended Bentley School of Accounting of Boston for two years. Miss Clapp recently was awarded one of Boston University's eight National Science Foundation fellowships for undergraduate research participation in chemistry.

The competition sponsors awarded her a certificate and will donate $100 in chemistry books to the University's Chenery Library in her name.

This marks the fourth time in the competition's five-year history that a Boston University student has finished first or second in New England.

Atoms Often Closer in Gasses

➤ USING an improvised high-temperature electron diffraction apparatus, an international team of scientists at Cornell University has evolved a new technique which has proven that the atoms in gaseous molecules at very high temperatures are often closer to each other than at low temperatures in the solid state.

By so doing, the team headed by Prof. Simon H. Bauer and Associate Profs. Richard F. Porter and Benjamin Widom, has opened up a new frontier in basic research.

As a result of their work, other scientists and engineers will be better able to cope with the problem of intense heat in space travel, and will be able to develop many new uses for existing elements and compounds.

For more than 10 years, the scientists had been measuring distances between the atoms in various molecules. Then, during the past year, they converted their electron diffraction apparatus for high-temperature operation.

Their redesigned apparatus succeeded in measuring the distance between the atoms in molecules of several substances. In many cases the atoms are still close together in the gas at temperatures up to 1000 degrees Kelvin they have discovered.

There are many substances for which it was believed that in the gaseous state atoms are broken apart into the smallest fragments. This apparently is not the case. There is a tendency

to clump in pairs, triplets and more complicated groupings.

For example, the measured distance between two atoms of chlorine in the salt-like substance, lithium chloride, or LiCl, is greater than at high temperatures in the dimer, $(LiCl)_2$, produced by heating the salt. The distance between two chlorine atoms was 3.62 angstroms (250 million angstroms equal one inch), and the angle of each one of the two lithium atoms to the two chlorine atoms was 105 degrees.

Although a few scientists had suspected that there is a tendency toward polymerization at extremely high temperatures, no one had succeeded in measuring the distances between atoms and proving it.

The high temperature electron unit built by Cornell researchers is the first of its kind outside the Iron Curtain, Professor Bauer said, "although the Russians are known to be interested in pursuing such research."

As a result of this work, the National Science Foundation has awarded Cornell a grant of $20,000 for 18 months to build a new, high-temperature electron diffraction unit capable of determining the molecular structures of metal oxides and halides in the vapor phase at temperatures ranging from 500 to 2000 degrees Kelvin.

"Once we have built our new unit we will systematically make measurements and calculations that will lead to an understanding of the properties of molecules over a wide range of conditions," Professor Bauer said.

Among the current members of the Cornell research team are a Japanese, a Chinese, a Dutchman, a Belgian and an Englishman. Scientists from all over the world, at Cornell to pursue advanced studies for varying periods of time, have contributed to the development of the project.

Determination of molecular structures of materials at high temperatures is obtained from diffraction patterns produced when a narrow, 50,000-volt beam of electrons is scattered by a jet of the molecules through which the electron beam is passed.

The pattern of concentric rings of varying spacing and intensity are recorded photographically. The photographic densities which are quantitatively related to the scattered electron intensities are measured by means of a microphotometer.

Extensive computation that must be made is performed by an electronic calculator.

Another technique for the study of materials at very high temperatures is the use of shock tubes. For chemical applications these are generally operated in a temperature range of from 1000 to 6000 degrees Kelvin. But the materials are exposed to this temperature for very short periods of time only.

Still another technique is the use of a mass spectrometer which permits one to analyze the gases that come off the tested substances when raised to high temperatures.

"It is unlikely that much new information can be added to existing knowledge with test tubes," Professor Bauer said. "All these techniques require large expenditures and have been made possible by grants from the Army, the Office of Naval Research, the Air Force and other donors to research projects."

Nuclear Reactions in the Sun

by Frank Dodd Smith, Jr.

➤ The object of my project, *Nuclear Reactions in the Sun,* is the exploration of the characteristics of nuclear reactions which occur in the sun. These reactions make themselves felt on earth by the sunlight which they produce.

In particular, the goal is the calculation of the rate at which these reactions occur, a useful quantity in the theory of evolution of the sun.

Such calculations are carried out by a combination of the laws of physics and results of observations of the sun itself.

All energy sources on earth, other than the nucleus, are directly or indirectly derived from the sun. Coal is an example of this, being composed of the remains of Carboniferous Period plants in which solar energy has been stored for centuries.

As nuclear reactions are the source of solar energy, it is only natural that man should be curious as to their characteristics. Being prompted by this curiosity, as well as by an intense interest in astrophysics, I chose for the topic of my project nuclear reactions in the solar interior.

Before nuclear reactions in the sun can be considered, a description of the sun itself is necessary. In order to draw conclusions about the interior of the sun, assumptions must be drawn from observational data.

As the sun exhibits no great variations in radius, it may be considered to be in hydrostatic equilibrium. This means simply that the gravitational pressure inward is balanced by outward gas and radiation pressure. As radiation pressure is not very large, hydrostatic equilibrium equations hold in the sun.

Thermal equilibrium is an extremely important factor in the theory of solar structure. As temperature at any distance r from the solar center may be calculated through use of equations for a perfect gas, it is found that the temperature gradient, or $Tr - Tr + dr$, where dr is a small distance from the solar center, is very low.

Even though the temperature gradient is low, it must be present for the following reason. The sun has a certain luminosity that is produced by an outward energy flux. This flux, though large for the entire sun, is small between two spherical shells at distances r and $r + dr$ from the solar center. In order for the flux to be outward, the temperature must be higher in the shell at r than in the one at

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➤ Frank Dodd Smith, Jr., *was given honors in the 18th Annual Science Talent Search for the Westinghouse Scholarships and Awards. His ambition is to teach physics in college while doing basic research.*

Information about the Science Talent Search may be obtained from Science Service, 1719 N St., N.W., Washington 6, D. C.

$r + dr$. When this is the case, a little more energy is produced at shell r than at shell $r + dr$, therefore the net flux is outward. However, such a flux and its consequent temperature gradient have very little effect on thermal equilibrium. As a result, the black body laws of radiation hold within limits of error.

Also, the dimensions and composition of the sun must be known. The radius is measured by observation, and is found to be 6.95×10^{10} cm. The mass, calculated from its accelerating effect on the earth by means of the laws of dynamics, is found to be 1.992×10^{33} gm. Its composition by mass is 73% hydrogen, 25% helium, and 2% heavier elements.

As the central temperature is 1.46×10^7 °K, proton reactions will take place, but those involving incident particles of higher atomic number will be forbidden.

In this project, certain simplifications have been introduced to facilitate calculation. Only the inner 11.3% of solar mass (12% solar radius) is considered. Although this procedure completely omits reactions occurring in outer regions, the advantages in calculation overshadow this. First, the abundance ratios of nuclides involved in the carbon cycle and proton-proton chain that are calculated at a temperature of 1.3×10^7 °K are readily available to me. As the average temperature of the inner 11.3% solar mass is 1.29×10^7 °K, with small variations (1.46×10^7 °K to 1.20×10^7 °K), these ratios may be used without great error. Secondly, complications brought about by allowances for wide variances in temperature and composition are avoided.

In order to compute nuclear reaction rates, the composition is needed. As only the inner 11.3% of solar mass is considered, nuclear abundances are given only for this region. These abundances may be found in the appendix. To calculate them, a model of the present sun,[1] spectroscopic abundances, and abundance ratios for a temperature of 1.3×10^7 °K were used.

Much of the hydrogen has been converted into helium by reactions in earlier evolutionary phases, giving a mass abundance of 60% in the inner region. As a result, the helium abundance has risen to 38%.

Due to their high reaction rates at comparatively low temperatures, lithium, beryllium, and boron have been literally burned up in the solar center during earlier evolutionary phases.

Abundance ratios are important in figuring the nuclear abundances of elements of the carbon cycle and proton-proton chain, as these two reaction chains are prevalent in the sun. These ratios are calculated by reaction equilibrium considerations for a temperature of 1.3×10^7 °K.

Other cycles, as neon-sodium, magnesium-aluminum, and silicon-phosphorus, are neglected in computation since they are not too important.

Aside from the above considerations, the composition is considered to be homogeneous. Where necessary, isotopic abundance ratios for the earth were used, as the sun has a similar composition.

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[1] R. Weymann, *Astrophysical Journal, 126,* 208, 1957. Results I used were taken from a tabulation in *Structure and Evolution of the Stars,* Martin Schwarzchild, 1958, p. 259.

To calculate the reaction rate of a particular reaction, five factors must be considered. The first of these is the number of particles of each kind.

Next is the probability of collision, which is given by the product of the relative velocity and the square of the De Broglie wavelength.

The probability of penetration of the coulomb barrier is necessary, as all particles participating in the reactions under consideration are charged. This is given by the Gamow barrier penetration factor, a function of energy and charge.

If collision occurs, the probability of the occurrence of the particular reaction under consideration, or "branching ratio," must be given. As the energies in the sun are small and only exoergic reactions need be considered, this factor may be treated as a constant.

The last factor, but a most important one, is the Maxwellisn distribution of relative velocity, a function of temperature and velocity. This gives the number of particles of each kind with each discrete relative velocity.

When these factors are combined, with temperature and composition held constant, and integrated over all velocities, the resulting formula for the reaction rate is

$$N_A\ N_B\ P_{(P)} \int P_{(V)}\ D_{(T,V)}\ Vq_{(V)}\ dV$$

where N_A and N_B are abundances of particles of type A and B, respectively; $P_{(P)}$ is the branching ratio; $P_{(V)}$ is the Gamow factor; $D_{(T,V)}$ is the Maxwellian distribution; and $Vq_{(V)}$ is the product of the relative velocity and the square of the De Broglie wavelength.

After appropriate substitution, the result is

$$N_A\ N_B\ P_{(P)} \frac{1.64 \times 10^{-33}}{(m_r\ T)^{1/2}} \int_c \left(-\frac{1.37 \times 10^9\ Z_A\ Z_B}{V} - \frac{6.10 \times 10^9\ M_r V^2}{T}\right) \frac{dV}{V}$$

As this is not directly integrable, statistical methods must be utilized. Fortunately, a narrow range of velocities makes the bulk of contributions to the reaction rate. This maximum velocity occurs where the product of the Gamow factor and the Maxwellian distribution has a maximum.

The physical significance of this is readily seen, as particles with low velocities have an extremely low probability of penetrating the coulomb barrier, whereas those with high velocities are too rare to make an appreciable contribution to the reaction rate. As a result, it is seen that the narrow limits of velocity mentioned above are present.

As the project now stands, it is incomplete. The branching ratios have not been obtained and the statistical integration has not been carried out. However, some interesting results have been obtained in calculating the velocity of maximum contribution, although they are not new to the scientific world. A tabulation of the maximum velocities and maximum kinetic energies for nuclides hydrogen through argon, as well as for iron, has been made and is given in the appendix. However, as lithium, beryllium, and boron are not present in the

solar interior, no values are listed for them. It is seen that the maximum kinetic energy rises sharply with increasing atomic number. This is borne out when a graph of the kinetic of maximum contribution, referred to as maximum kinetic energy, is plotted against atomic number. The resulting graph, which is given in the appendix, is almost a straight line for the heavier nuclides (carbon to iron).

As the average kinetic energy is 1.66 x 10^0 kev, and higher kinetic energies are increasingly rare, the reaction rate tapers off with rising atomic number. This is illustrated by the high maximum kinetic energy (21.6 to 58.5 kev) of the heavier nuclides.

The project, as was stated above, is now unfinished. However, after these particular calculations have been completed, I hope to extend the scope of the project.

This would mean more refined computations on solar rates, and then applications of the more accurate techniques to stellar interiors in which the temperature is of the order of 10^8 °K, where alpha particle reactions take place.

Next, a study of nuclear reactions in stellar interiors with temperatures on the order of magnitude of 10^9 °K, where a multitude of reactions occur, would be most desirable. In this work, the origin of the elements and the possible cause of supernovae could be explored.

Inasmuch as the reactions at temperatures of about 10^7 °K and 10^8 °K, as well as many of those at temperatures of about 10^9 °K, have been well covered by theoreticians far more able than I, the only opportunity for original investigation is the study of some of the reactions that occur at a temperature of about 10^9 °K.

It is there that the chance for a true scientific contribution occurs, although the entire project has immeasurable personal value in experience.

APPENDIX

TABLE I

A model of the present sun, by R. Weymann, Astrophysical Journal 126, 208, 1957. Results reprinted in Structure and Evolution of the Stars, Martin Schwarzchild.

Radius/Solar Radius	Mass/Solar Mass	Log_{10} Temperature	% Hydrogen (mass)
0.00	0.000	7.165	49.4
0.02	0.001	7.162	49.8
0.04	0.006	7.154	52.0
0.06	0.018	7.141	54.5
0.08	0.040	7.123	57.1
0.10	0.073	7.102	61.1
0.12	0.113	7.080	64.3

TABLE II

Statistics of the inner 11.3% of solar mass.

Mass	2.25×10^{32} gm	1.35×10^{56} MU
Average Temperature	1.29×10^{7} °K	1.11×10^{0} kev
Radius	1.67×10^{10} cm	
Volume	1.95×10^{31} cm^3	
Average Density	1.15×10^{1} gm/cm^3	6.92×10^{24} MU/cm^3
Hydrogen (Total)	1.35×10^{32} gm	8.13×10^{55} nuclei
Hydrogen/cm^3	6.93×10^{0} gm/cm^3	4.15×10^{24} $nuclei/cm^3$
Average Kinetic Energy	1.66×10^{0} kev	

TABLE III

Abundances, maximum velocity, and maximum kinetic energy of nuclides of the inner 11.3% solar mass.

Nuclide	Number of Nuclei in Inner 11.3% Solar Mass	Maximum Velocity (cm/sec)	KE of Maximum Contribution (kev)
H^1	$8{:}13 \times 10^{55}$	1.43×10^{8}	5.34
H^2	1.22×10^{39}	1.30×10^{8}	5.88
He^3	2.77×10^{51}	1.57×10^{8}	9.64
He^4	1.27×10^{55}	1.54×10^{8}	9.89
C^{12}	1.01×10^{51}	2.12×10^{8}	21.6
C^{13}	2.12×10^{50}	2.12×10^{8}	21.6
N^{14}	2.22×10^{52}	2.22×10^{8}	24.0
N^{15}	7.20×10^{48}	2.22×10^{8}	24.1
O^{16}	4.08×10^{52}	2.32×10^{8}	26.4
O^{17}	1.42×10^{49}	2.32×10^{8}	26.5
O^{18}	7.37×10^{49}	2.31×10^{8}	26.4
F^{19}		2.40×10^{8}	28.6
Ne^{20}	3.71×10^{52}	2.48×10^{8}	30.6
Ne^{21}	9.91×10^{49}	2.48×10^{8}	30.6
Ne^{22}	3.28×10^{51}	2.48×10^{8}	30.7
Na^{23}		2.56×10^{8}	32.8
Mg^{24}	2.69×10^{51}	2.64×10^{8}	34.8
Mg^{25}	3.30×10^{50}	2.63×10^{8}	34.7
Mg^{26}	3.55×10^{50}	2.63×10^{8}	34.8
Al^{27}		2.70×10^{8}	36.6
Si^{28}	2.69×10^{51}	2.77×10^{8}	38.7
Si^{29}	1.32×10^{50}	2.77×10^{8}	38.6
Si^{30}	8.51×10^{49}	2.77×10^{8}	38.7
P^{31}		2.83×10^{8}	40.5
S^{32}	2.42×10^{51}	2.89×10^{8}	42.2
S^{33}	1.85×10^{49}	2.88×10^{8}	41.9

S^{34}	1.05×10^{50}	2.88×10^{8}	42.0
S^{36}	3.90×10^{47}	2.88×10^{8}	42.0
Cl^{35}		2.95×10^{8}	44.1
Cl^{37}		2.94×10^{8}	43.8
Ar^{36}	1.54×10^{50}	3.00×10^{8}	45.7
Ar^{38}	2.58×10^{48}	3.00×10^{8}	45.7
Ar^{40}	4.08×10^{51}	3.00×10^{8}	45.7
Fe^{54}	8.82×10^{49}	3.38×10^{8}	58.5
Fe^{56}	1.34×10^{51}	3.38×10^{8}	58.5
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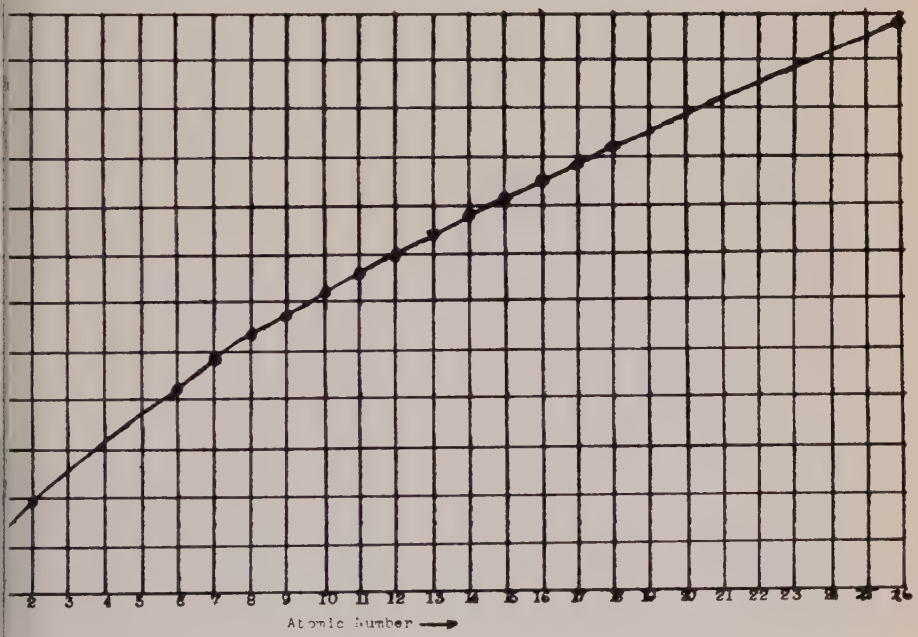
Fe^{58}	4.37×10^{48}	3.38×10^{8}	58.5



Rocket Thrust Predictable

➤ Aeronautical engineers may be able to predict more accurately the thrusts of boron fuel rockets with the finding by an Ohio State University chemist that many boron-oxygen-hydrogen-type molecules remain stable at high temperatures. Dr. David White, associate professor of chemistry, told a meeting of the American Rocket Society that "at higher temperatures you get new kinds of molecules and often more complicated ones." "For the first time we have a set of correlatives of thermodynamic properties of boron fuels from which to calculate precisely rocket thrust."

Electroluminescence

Electroluminescence, a Way to Convert Electricity Directly Into Light, Could Illuminate Our Homes in the Not-Too-Distant Future. This Amazing New Form of Lighting Comes Paper-Thin and Can Be Fitted to Any Shape. In Ten Years Houses May Be Lighted by Electroluminescent Windows, Wallpaper, and Draperies.

➤ Windows, wallpaper, and draperies that glow to light the home at night could be standard equipment in the not-too-distant future. Electroluminescence, hailed as the most important lighting discovery since Edison's incandescent lamp and the fluorescent bulb, will be responsible.

The possible uses of electroluminescence indeed stretch the imagination. The lights need not be in set shapes of bulbs or tubes. Electroluminescence can provide area lighting, two-dimensional lighting that can come in any shape. Thin layers, a few thousandths of an inch thick, of an electroluminescent source might be used to cover ceilings and walls. Windows coated with the material could transmit sunlight in the day and light the room at night.

Operation

"Electroluminescence" means the direct conversion of electricity into light. It is accomplished by exciting a thin film of phosphors with an alternating current. The phosphor film is sandwiched in between two electrically conductive surfaces, at least one of which is translucent. The "bread" of the sandwich can be a mesh of tin oxide, no thicker than the "meat."

When the alternating current is sent through the outer layers an alternating electric field is set up across the phosphors in the middle. The electric field "excites" or energizes the electrons in the phosphor layer. Essentially, as the electrons "calm down" they emit their excess energy in the form of light.

This method is akin to the principle behind fluorescent lamps and television sets. In all three light is produced by exciting a phosphor. In a fluorescent lamp, light is produced by the action of ultraviolet rays. Television sets show pictures because of a beam of high-speed electrons. And electroluminescent sources glow because the phosphors are excited by an alternating current.

But in one respect electroluminescence is different from all previous forms of lighting. The electricity is converted directly into light. There is no tungsten filament to heat white-hot as in the ordinary incandescent light bulb. The electricity does not have to be converted into ultraviolet radiation to produce, in turn, fluorescent lighting.

Versatile electroluminescence can change colors as quickly and as easily as the intriguing chameleon. A turn of a knob might change the color of the light from blue to red or white.

Technically, the colors are varied by mixing different phosphors or by changing the frequency of the alternating current. As the frequency changes different colors inherent in

the electroluminescent source are emphasized.

Use in Television

Electroluminescence can also form an image. A photoconductor, a material that conducts electricity in proportion to the amount of light falling upon it, is placed in front of electroluminescent material. When an image is focused on the photoconductor and when electricity is applied to the two layers, the photoconductor will translate the image into an invisible picture of varying voltage. The varying voltage, in turn, will be translated into a picture by the phosphors in the electroluminescent screen. The device can "see" things beyond the visible spectrum. It could be used to give a brighter X-ray picture than is now possible with the fluoroscope.

If an electroluminescent screen can be made to perform the function of a television tube, as it may well be made to do, our television sets no thicker than a painting will be hung on the wall. The bulky picture tube would be eliminated because the electroluminescent screen would translate the electric impulses into a picture without the intermediate step of bombardment of high-speed electrons.

There is a considerable amount of electroluminescent lighting in use today. Electroluminescent panels now are used as night plotting boards for the bridges of ships, instrument dials, and night lights for the homes. The 1960 Chrysler and Imperial automobiles will have electroluminescent panels illuminating their dashboards.

The panels, the most extensively used form of electroluminescence at the present, are made by coating a plate of glass with an electrically conductive layer. On top of this is placed the powdered phosphor layer embedded in plastic film. To complete the sandwich the inside surface of a protective moisture barrier is coated with a dielectric, or conducting layer, made perhaps of aluminum.

When a wire connected to the dielectric layer is plugged into an electric circuit, the panel glows. Instead of a glass-based panel, ceramic, plastic, or nylon might be used. With a nylon light source, soft draperies could be plugged into the wall and made to glow.

Present Problems

Before our homes are lighted by glowing ceilings, however, some major problems must be ironed out in the laboratory. Electroluminescence still is too costly to compete with filament, fluorescent, or mercury lighting, except where only a dimly glowing panel is needed, because the sources have a low brightness and a low efficiency at regular levels of voltage and frequency.

The brightness of the light can be increased in two ways. The strength of the current can be increased by raising the voltage or by quickening the frequency of the alternating field's oscillations.*

Both, however, have technical limits. Too strong a current will destroy the insulating properties of the phosphor film and too rapid a frequency will not give the electrons enough time to get "excited," to "calm down," and to emit light.

Even disregarding technical limits, the voltage and frequency of the elec-

* See, however, Prof. Destriau's patent on page 38 of the October issue of CHEMISTRY.

trical system would have to be raised to make a panel bright enough to light a room with electroluminescence. Consequently, a luminous ceiling would cost an estimated $12,000, ten times as much as a luminous ceiling of fluorescent lamps behind diffusing plastic.

Considerable progress has been made since intensive research on electroluminescence was begun in 1950. America's three largest electric light manufacturers, General Electric, Westinghouse and Sylvania, are conducting extensive laboratory research programs on electroluminescence.

Discovery and History

A Soviet physicist, in 1923, made the first known observation of electroluminescence.

At the city of Nizhni-Novgrod, Oleg Vladimirovich Lossev discovered that a crystal of silicon carbide properly oriented between two direct current electrodes will glow. Thirteen years later, a French scientist, Georges Destriau, found that an alternating current could excite sulfide phosphors to produce light.

But as Prof. Destriau recently recalled, his electroluminescent source was so dim that "you had to turn out the lights and adapt your eyes to the darkness before you could glimpse its faint light."

Indeed, these early efforts were considered mere laboratory curiosities. It was not until 1950 that industry became interested in electroluminescence and began intensive research.

And so the path of electroluminescence has run from Nizhni-Novgrod to France to American electrical laboratories. In a few more years it may be part of the American home.

Free Radicals in Cryogenics

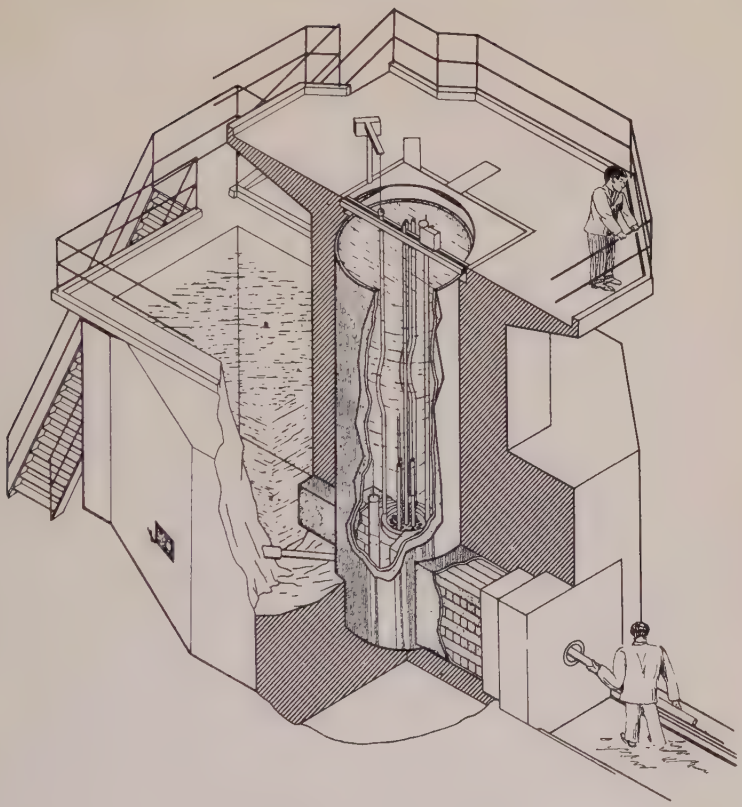
➤ The great promise of a new energy source, the use of free radicals trapped in their reactive state, is not in rocket propellants, as once thought, but in chemistry and physics.

Much progress is being made in understanding these fragments of molecules that usually exist only for thousandths of a second. For three days recently (Aug. 31 to Sept. 2), more than 400 scientists from the United States, Canada, Great Britain, Sweden and Russia met in Washington to exchange their latest research findings on free radicals.

Particular emphasis was given to the trapping of free radicals at very low temperatures, within a few degrees of absolute zero, which is 459.7 degrees below zero Fahrenheit. The study of free radicals has pointed up the present-day trend toward low-temperature chemistry, Dr. H. P. Broida of the National Bureau of Standards explained. Dr. Broida headed a three-year program at N. B. S. in which Government, university, and industrial scientists cooperated to learn more about the physical and chemical properties of free radicals.

One possible practical application of free radicals, he suggested, could be in an infrared detecting device. Free radicals occur in the chemical reactions of living tissue, in the hot atmospheres of the sun and other stars, and in automobile and rocket engines. They are formed when molecules are broken up by applying energy to them.

U. of Illinois Builds Reactor



➤ An above-ground tank-type nuclear reactor for teaching and research purposes will be constructed at the University of Illinois. First operation is scheduled for next spring.

The reactor will be used for instruction in the university's new graduate nuclear engineering program. In addition, the device will be available to manufacture isotopes for other research applications. Short courses to train industrial personnel are also anticipated.

Initial power output will be 10 kilowatts, eventual capability 100 kilowatts or more. Active fissionable material will be 4½ pounds of uranium-235.

Fuel is especially designed to be self-limiting as an ultimate safety factor.

The original prototype TRIGA, at General Atomic Division's John Jay Hopkins Laboratory for Pure and Applied Science in San Diego, recently made atomic history when it was

"flashed" from one watt to a peak power of 1.5 million kilowatts (thermal) in less than one-tenth of a second. It immediately and automatically leveled itself off to a normal operating level, due to the unique safety characteristics of its homogeneous fuel-moderator elements. The test represented the highest energy level ever attained by any reactor, of any size or type, in controlled operation.

Added safeguards are a windowless laboratory building and control of exhaust air. Though accessible, all radiation zones are below outside ground level to avoid stray radiation.

The reactor tank, filled with purified water, will be 6 feet in diameter and 21 feet tall. Fission activity by 4½ pounds of uranium-235 with zirconium hydride will be at bottom of central water-filled tank 5 feet in diameter and 21 feet tall. Students and visitors will safely view operating fuel assembly through the purified water. An adjacent pool, 9 by 12 feet, is for studies of radiation shielding carried on through the protective water covering. The base of the structure is surrounded by 7½ feet of concrete shielding and is below ground level for complete safety. Four ports in the shield give access to neutron beams and allow materials to be inserted for irradiation.

Guiding the reactor and teaching program is an interdepartmental committee for the College of Engineering, headed by Prof. Ross J. Martin, Director of the Engineering Experiment Station. All departments are cooperating in the effort, with courses or research interests drawn from nearly all fields of engineering and science.

Students in this specialty must have a bachelor's degree in engineering or science. They study for a master's degree in nuclear engineering, and may use this field as a minor toward the doctorate. First graduates received master's degrees this year.

Comet Cloud in Solar System

➤ The sun is surrounded by a large cloud of comets, most of them at such vast distances they are invisible from earth.

These comets may have been formed at the same time as other members of the sun's system from the original gaseous cloud, and with further growth might have become asteroids or even planets. Thus studies of comets can provide much insight into the origin of the solar system.

Comets have very low temperatures, and are believed to be composed of icy mixtures of frozen matter .Even when comets approach relatively close to the sun, they remain extremely cold. Their temperatures then reach only to about 150° Kelvin (absolute), due to the cooling effect when the comet's volatile gases are released by solar heating, Dr. Bertram Donn of Wayne State University, Detroit, has calculated.

Because comets are so cold throughout their lifetimes, they probably have not undergone any extensive chemical changes since their formation from the original solar nebula.

This report on comets and cosmic chemistry appears in the current Sky and Telescope (August), journal for astronomers, published in Cambridge, Mass.

Rates of Chemical Reaction

by Sir Hugh Taylor

This excerpt from an address by the professor emeritus of chemistry at Princeton before the American Rocket Society - Northwestern Gas Dynamics Symposium, Evanston, Ill., explains the impact of potential energy barriers upon some of the most advanced applications to problems of national security and welfare. Sir Hugh is now president of the Woodrow Wilson National Fellowship Foundation.

➤ Fifty years ago, Bodenstein and Lind were leisurely measuring the rate of reaction of hydrogen and bromine; their fastest measurement occupied twenty minutes. Today, the rates of reaction in fractions of milliseconds are the objective of shock-wave studies. This symposium is concerned with problems in the production of high velocity gas streams which will be necessary for propulsion in the space age. The new studies demand all the rich resources and techniques that recent decades have brought.

Even thirty years ago we were largely empirical in our approach to the theoretical treatment of rate processes. We knew that there was a definite inertia associated with each chemical reaction. Polanyi had examined processes in which every collision resulted in reaction and other very similar processes where the collision efficiency was not more than one in a million. We knew that atom-molecule reactions were, in general, considerably more efficient, collision-wise, than molecule-molecule collisions. Indeed, a whole structure of chain-mechanisms of a wide variety of interactions, oxidations, halogenations, polymerizations and even thermal decompositions, had been formulated on the basis of this difference in reactivity between atom-molecule or radical-molecule reactions on the one hand and reactions between molecules on the other.

Energy Barriers

It was during the 1930's that we came to understand the potential energy barrier that separates reactants from products in any chemical system, that the rate of chemical reaction could be measured by the rate of passage of an activated complex, produced by the collision process, over the potential energy barrier. It was the more energetic of the collision processes that overcame the potential energy hill between the impacting species; thanks to a beneficent Boltzmann principle we could therefore formulate the influence of temperature on the rate processes.

We have reason to be thankful for these potential energy barriers since they allow us to enjoy a bewildering variety of materials which the relentless operations of free energy would destroy were the processes of change not equally relentlessly slow. To impress this on students it was possible to call their attention to the fact that the diamond in the engagement ring that they might someday present to

their fiancées was really an unstable form of carbon, that, but for the operation of chemical inertia, it could decrease in free energy with the formation of graphite, by no means so acceptable to the fair lady, but thermodynamically more stable. Similarly, the myriad carbon compounds in an oxygen, or even a hydrogen, atmosphere owe their existence to the grace of chemical inertia instead of undergoing a transformation to carbon dioxide and water or to methane, with liberation of abundant amounts of free energy.

Potential energy barriers have become enmeshed in problems of national security. The problems of storage and utilization of hydrogen peroxide, nitrogen tetroxide, ozone, of atoms and free radicals, hinge on the barriers separating reactants and products. Hydrogen peroxide is an excellent example of the effort required and the success achieved in solving the problem of stability in what was once considered a material highly susceptible to decomposition. Now, in concentrations greater than 90 per cent, it is stored in 25000 gallon tanks and safely transported in 8000 gallon tank cars. This has called for the most discriminating care in the selection of container materials, for example, pure aluminum, with minimal content of catalytically active materials such as copper, as also in valves, lines and pumps for transfer purposes.

Once we had learned the nature of chemical inertia we began to understand what the catalytic chemist had to do. It was his task to find an energetically easier pathway from reactants to products than was possible in the absence of the catalyst. He had to discover the lowest pass in the mountain range of potential energy separating raw materials from final products. He could think of the California Zephyr en route from Denver to Salt Lake City and the acceleration in the journey when the railroad engineers bored the Moffat Tunnel to avoid the climb to the lowest pass in the Divide. A laborious climb of several hours was changed to a swift passage of a few minutes. Thus it was that the iron catalyst provided a rapid pathway to overcome the excessive inertia of nitrogen and hydrogen mixtures and thus facilitated the synthesis of ammonia. Lord Salisbury once said that you could measure the civilization of a country by the amount of sulfuric acid produced. Synthetic ammonia is now a more appropriate measuring stick. Perhaps the absence of 'smog' in the populous, automobile-rich areas of the land will become a measure of our skill and competence in matters catalytic. And, as we have just seen, the absence of catalytically active materials may well determine the successful achievement of product stability in many cases.

Heat Removal

Let us now examine a rate process which new engineering demands have produced, the rapid removal of huge quantities of heat generated in small spaces in rocket and jet aircraft engines and nuclear reactors. The classical heat exchangers, adequate for the chemical engineering problems of yesterday, contain sulfuric acid, ammonia synthesis, and internal combustion engine cooling, required heat fluxes of the order of 50,000 BTU per hour per square foot. Now fluxes in the millions of BTU are required, comparable, as Professor Westwater of Illinois has recently pointed out, to the

energy flux from the surface of the sun. These fluxes are achieved by boiling heat transfer. As Westwater observes:

"Ten years ago, calculation of boiling heat transfer was an art. Now it is realized that a knowledge of nucleation, the physical chemistry of surfaces, the growth, collisions and vibrations of bubbles, the stability and instability of waves between two phases, and viscous and turbulent flow theory are required. Information in all these fields is coming with a rush, and boiling heat transfer is becoming a science."

Salt Water Irrigation Successful

➤ A WHOLE new continent could be added to the world, according to Dr. Hugo Boyko of Israel. For many years now, Dr. Boyko says an experimental garden has been flourishing in the desert, watered only with brackish water from a saline spring. The soil is 61% granite and limestone pebbles and rocks, with about 23% coarse sand. No fertilizer is applied, the Israeli researcher said, yet pomegranates, mulberry trees, sycamores and olive trees are thriving. Altogether there are some 180 species of trees, shrubs and other plants, selected for their drought-resistance, and usually originating from arid or semi-arid Mediterranean regions.

These plants are living proof that desert soil and salt water can support an agriculture, Dr. Boyko explains. Farmers are used to associating salt or sea water with destruction of their crops, and sandy or gravelly soil is usually thought of as not being farm land. The two "evils", salt water and so-called bad soil, can be combined to give millions of acres of land for agriculture.

There is a good reason for this: salt water percolates through the coarse soil so that the plant's roots do not stand in the salty water. Effectively, the plant has all the benefit of the salt water without any of the harm.

Plants in the experimental garden were irrigated with water whose salt content ranged from 2,500 to 6,000 parts per million of salt in water. The amount varied with the season, Dr. Boyko explains. This saltiness is enough to make a person sick if he were to drink it.

The only species that failed to survive under this irrigation were those with short root systems. The other plants were able to go three weeks, during an unusual drought, without irrigation. Actually, Dr. Boyko says, the plants needed less water than "you would suppose." Once a week was enough. Plants could also be irrigated with fresh water, following the salt water, without harm.

The salt does not accumulate since it passes down through the coarse soil. When it reaches bed rock, the salt is carried out to the sea.

Shifting sand dunes can also support a crop. Barley, sugar beets, wheat, grass and Israeli esparto grass, used in paper making, can all be grown, according to Dr. Boyko. These are all important economic crops. Water with a salt content higher than the Sahara's under-ground resources of brackish water was used for irrigation, and it may thus be possible to make productive the arid and semi-arid lands throughout the world.

Another In Series on Chemical Organizations

A. S. T. M.

➤ The American Society for Testing Materials (ASTM) is a national technical Society organized in 1898, and incorporated in 1902, with the charter objective of ". . . the promotion of knowledge of the materials of engineering, and the standardization of specifications and methods of testing."

The first organized meeting to discuss the subject of uniform methods of testing, which was beginning to assume considerable important in industry, was held in Europe in 1882. There was subsequently formed an International Association for Testing Materials and in 1898 an American section of this association was organized. After a short time it became evident to the American members that an independent organization could best carry out the important standardization and research work in this country and in 1902 the present Society was incorporated.

That part of ASTM work which has to do with the "promotion of knowledge of the materials of engineering" is effected through investigations and research by committees and individual members of the Society and by joint researches with other groups, results of which are presented as papers, reports and discussions at Society meetings and subsequently published.

The "standardization of specifications and methods of testing" is carried out chiefly by some 80 technical committees, each of which has under its jurisdiction engineering materials in a definitely prescribed field or some specific phase of materials testing. Each of these committees is a vital and inherent part of the Society's organization.

The membership is drawn from many of the more important industries of the country. The members may be roughly classified into three groups: consumers of raw materials and semi-finished and finished products, producers of materials, and a general interest group, comprising engineers, scientists, educators, testing experts, research workers, etc.

Membership is open to all those interested in the purpose and work of the Society and may be held by individuals, companies, corporations, associations, laboratories, governmental departments, technical schools and libraries.

There are almost 10,000 members currently enrolled in the Society; about 7500 are individuals; 2000 are company members, and 480 are Sustaining Members. In addition there are some 6000 Committee Members, engineers and scientists representing companies on the technical committees.

The Society maintains an extensive publication schedule to make available to all engineers and scientists the ac-

cumulated research information, data and standards.

The ASTM Book of Standards is the most comprehensive publication of its type. There are 10 parts, containing 2500 standards. This book issued triennially contains 14,000 pages. Each part is supplemented yearly between regular editions.

The Proceedings serves as the official repository for reports of the Society's Committees. The volume also contains technical papers and discussions of high permanent value.

The ASTM Bulletin serves as a new medium for the Society. Published 8 times each year it contains not only news of current activities, but also timely technical papers.

Periodically the Society publishes the Book of ASTM Methods of Chemical Analysis of Metals, which contains all analytical procedures for ferrous and non-ferrous metals including spectrochemical and photometric methods, published by the Society. In addition, the Society publishes the ASTM Standards in compilations serving particular fields such as Petroleum, Plastics, Steel, etc. Individual standards are also made available. An Index to all standards published by the Society is printed yearly and single copies are distributed free of charge to anyone interested.

Special Technical Publications from 40 to 400 pages in size and dealing with a variety of subjects are published. Some 20 to 30 of these STP's are made available each year. A Year Book listing members and other details about the Society is published.

The Society has a comprehensive program of meetings. The Annual Meeting held in late June each year brings together some 3000 technologists, engineers and scientists for committee work, presentation of scientific papers and discussions. Usually some social events are included in the program such as industry lunches and dinners. On alternate years an exhibit of laboratory equipment and scientific apparatus is held.

Preparatory to the Annual Meeting a Committee Week is held in February to allow the technical committees to prepare their work for presentation to the Society as a whole. A technical program is often planned in conjunction with this meeting.

At approximately 3-year intervals Pacific Coast National Meetings are held. Extensive technical, committee and social programs are part of these meetings.

The Society has 17 districts encompassing most of continental United States. These districts sponsor 30 to 40 local and regional meetings. Programs of technical and semi-technical nature are featured.

Rapid progress is being made in many fields of technology today. The Society, through its members, technical committees and through cooperation with numerous other technical, professional and trade organizations is helping to foster an awareness of the importance of materials in these technical advances.

Of particular interest to chemists is the work being done in spectroscopy (emission, absorption and mass), radioisotopes, chemical analysis of metals, halogenated organic solvents, casein and protein materials, cellulose, water analysis, plastics, adhesives, rubber, petroleum, and a host of other fields.

Translucent Ceramic

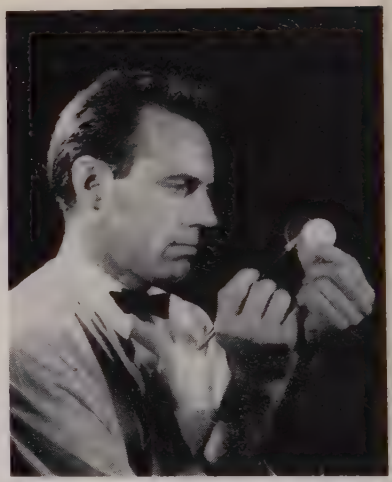
➤ A NEW CERAMIC material described as "history-making" in its unique combination of properties has been announced by Dr. Guy Suits, vice president and director of research for the General Electric Company.

"For the first time in history," said Dr. Suits, "a polycrystalline ceramic that readily transmits light has been made from powders. In addition to transmitting light, the new material possesses the extremely high strength characteristic of alumina ceramics, can withstand much higher temperatures than most ceramics now in use, and can be pressed into any shape desired. No other material combines translucence with this degree of strength, heat resistance, and ease of fabrication."

"Lucalox," as General Electric calls the new material, is made from powdered aluminum oxide. It is closely related to sapphire and ruby gem stones, which are single-crystal aluminum oxide. But this polycrystalline form of the same compound is superior to these gems in its ability to withstand high temperatures without deforming. Lucalox has the composition of a ceramic, the structure of a metal, and the light-transmitting ability approaching that of glass.

The unique characteristics of Lucalox result from the fact that the microscopically small pores, or "bubbles," that are normally found in ceramic materials have been entirely removed, a feat that had been previously considered impossible.

Because of the elimination of the pores, it is possible to read through a sheet of Lucalox when it is laid flat upon a piece of paper. At greater distances it appears translucent, resembling frosted glass. At least ninety per cent of the light in the visible spectrum is transmitted through the new ceramic.



➤ INVENTOR *of new ceramic material, Dr. Robert L. Coble, of the General Electric Research Laboratory, compares a sample of the new ceramic with a conventional ceramic. Named Lucalox, the new material combines translucence with strength and the ability to withstand extremely high temperatures.*

The basic material of Lucalox is fine-grain, high-purity aluminum oxide, or "alumina." The powder is pressed at room temperature, then fired at temperatures that are higher than usual for ceramics.

Lucalox was first made by Dr. Robert L. Coble, of the General Electric Research Laboratory.

This is thought to be one of the

most significant advances in the field of ceramics in hundreds of years. Lucalox resulted from an extensive investigation of the basic principles of the sintering process. Its creation represents an achievement of the first order, illustrating our ability to create entirely new materials when we gain better understanding of the fundamental scientific processes involved.

The development of Lucalox should greatly enlarge the scientific, military, and industrial uses of ceramics.

As has been the case with many new materials, Lucalox should also extend the range of instruments and devices that are presently limited by the physical characteristics of those materials now available. One example would be high-intensity incandescent and discharge lamps, which are now limited by the heat-resistance of their transparent envelopes, in some cases. Fused quartz, which is often used for high-temperature lamps, performs satisfactorily up to 1800°F; Lucalox is stable at temperatures close to 3600° Fahrenheit.

Another likely application for Lucalox is in the banks of infrared lamps that are used to test the heat-resistance of missile nose-cones and other space-vehicle equipment. It may also be used as an electrical insulator and as a material for gem bearings in delicate equipment.

Present ceramic materials can be divided into three general categories:

Conventional ceramics, such as porcelains, in which the crystals are bonded together by low-melting glass — these approach, but do not reach, the 100 per cent density of the new material. They are limited by the low melting point of the bonding glass.

Oxide ceramics, more-or-less single phase — these are stronger than the porcelains, but, filled with light-scattering pores, they are opaque.

Single crystals, such as sapphire and ruby — these are transparent, but are limited in size and shape and are extremely difficult to fabricate.

Lucalox has a metal-like structure, in that its crystals are bonded directly to one another, with neither pores nor a glass matrix between them. Information gained from the study of this material may consequently be applied to powder metallurgy.

Tough Metal Coatings Made from Soybean Oil

➤ Films made from soybean and linseed oils have been shown to provide tough, flexible coatings for aluminum and black iron.

Chemists at the Agricultural Research Service northern utilization research and development division at Peoria, Ill., reacted fatty alcohols produced from soybean and linseed oils with welding-grade acetylene to produce vinyl ethers. By polymerization the vinyl ethers were joined together to form giant molecules that make up the films.

The coating films are flexible and withstand heat. They resist abrasion, alkalis, acid and such solvents as alcohols, mineral oil and benzene. These properties make them very well suited for metal coatings, it is reported in Agricultural Research (September) published by the U. S. Department of Agriculture.

Soybean and linseed oil films also may be used in adhesives, concrete and masonry paint, the USDA says. The research on the metal coatings is still in the laboratory stage.

More Non-Conformists Needed

➤ We need non-conformists, individualists, in the scientific, as well as the artistic world, according to Dr. Harold Gershinowitz, president of Shell Development Company.

Dr. Gershinowitz, who heads the research and technical arm of Shell Oil Company, spoke to fifty teachers completing this summer's Shell Merit Fellowship seminar for outstanding high school science and mathematics teachers at Stanford University.

The seminar, held each year for 100 teachers, 50 at Stanford and 50 at Cornell, is supported by Shell Companies Foundation, Inc. to strengthen further secondary training in chemistry, physics, and mathematics.

Speaking about "The Mind of a Scientist" Dr. Gershinowitz said "the very nature of science and the scientific method demand from the scientist ways of thought which are incompatible with conformity."

"The participant in scientific activity must endeavor to change the status quo," he said. "Every new bit of data, every new theory or insight, invalidates to some extent what was known or understood before. Authority is transient, laws are mutable, facts are temporary," he continued.

"As teachers of science and mathematics," Gershinowitz told the teachers from the Western States, "it is important for our future that you be able to recognize early signs of talent so that you can steer into productive outlets the curiosity and rebelliousness of your students. It is the uncommon man who makes the organization grow and prosper."

Dr. Gershinowitz pointed to Soviet Russia as an example of what dogma and authoritarianism can do to creativity. "Innovation in science is tolerated only when it is needed for the competitive art of war, but denied, as in genetics and psychology, when it is not," he said.

Dr. Gershinowitz pointed out that non-conformity and the questioning of authority are essential ingredients of innovation.

Intelligence and intellectual capacity, he said, are essential for scientific and mathematical creativity, although the real rebels of the intellect are rare.

In closing his speech, Dr. Gershinowitz gave these thoughts on the scientific mind. "I hope," he said, "that our educational processes can be flexible enough to tolerate the inquisitive, skeptical, often rebellious student.

We still know very little of the nature and origin of scientific and creative ability. We do not know whether such ability can be developed but we do know that it can be aborted or stifled. I hope that I can encourage you to look for it in your students. It is not easy to get along with the innovator. I know that from experience. But as a spokesman for industry I can assure you that we want and we need the individualist, the nonconformist, the rebel with a cause. As a citizen I hope that our social pressures and educational methods will continue to pick out such individuals and make it possible for them to preserve by innovation our freedom and our way of life."

Chlorophyll Harnessed

➤ The ways plants use the sun's energy is being studied in a 10-year-old research project which may one day provide the information to revolutionize man's concept of power.

Dr. Richard C. Nelson, associate professor of physics at Ohio State University, has been trying to find out how to induce the energy absorbed by chlorophyll to perform work.

The associate professor of physics was the first man to succeed in converting light into electrical energy, using pure chlorophyll as the active agent.

Dr. Nelson first demonstrated his theory of electron transfer in a paper published in the Journal of Chemical Physics in 1957 and 1958.

He explained the theory this way: "You shine light on a molecule of chlorophyll dye. The energy of the light is picked up by a single electron, which increases its potential. The potential energy then can be converted into electric voltage.

"This can be compared to a pump which pushes water uphill to a point above a water wheel. Once it is above the wheel, the water represents potential energy. When the water spills down over the wheel, it turns it and performs work energy," the physicist explained.

He said the electron has to pass in some orderly, controllable way to a lower state before its energy can be used.

In working out his theory, Dr. Nelson built what he calls a "photovoltaic cell," which converts light into electricity. When light is shined on chlorophyll dye, electrons hop from one molecule to another to build up a sort of light battery.

He said most dyes, such as chlorophyll and pigments in the retina of the eye, become conductors of electricity when they are illuminated. The dye molecules have to be lined up properly to make an efficient machine to produce electric current. In the plant, he said, the plate-shaped chlorophyll molecules have tails which act as pegs to hold the molecules in an orderly pattern.

"The molecules must be grouped in an orderly way so the electrons will be able to jump quickly from one to another," Dr. Nelson said. "This increases the probability that they will be able to perform useful work."

The researcher has been trying to discover the principles explaining the process of photosynthesis. He is concerned with the problem of energy transfer and hopes to discover how to make the transfer in a useful way.

Dr. Nelson said some of the principles of photosynthesis could possibly be employed in developing solar energy. A one-foot-square device, such as his photovoltaic cell, would be capable of powering a small electric motor on rays from the sun, if the layers of chlorophyll and cadmium sulfide (a yellow pigment) were thick enough and the molecules arranged in proper order, he said.

After years of investigating the physical properties of different dyes, it was possible to document a kind of energy transfer process. He made it clear that the photosynthesis process probably never can be reproduced with artificial materials, such as dyes.

➤ Dr. Richard C. Nelson, *associate professor of physics at Ohio State University, explains his photovoltaic cell which generates up to ½-volt of electricity when light is shined on the dye-coated plate inside. The scientist made the device while working out his theory of electron transfer.*

New Scientific Terms

➤ Tera, giga, nano and pico are new scientific terms just adopted to denote very large and extremely small quantities.

The four prefixes are now being used by the National Bureau of Standards. Tera indicates a trillion and giga a billion. Nano is the prefix meaning a billionth and pico, a trillionth.

The prefixes followed by the multiple or submultiple denoted in figures, are: tera — 1,000,000,000,000; giga — 1,000,000,000; mega — 1,000,000; kilo — 1,000; hecto — 100; deka — 10; deci — 0.1; centi — 0.01; milli — 0.001; micro — 0.000,001; nano — 0.000,000,001; and pico — 0.000,000,000,001.

Chemistry's Big Stick

➤ If the word "epoxy" sounds like alchemic jargon to you, you're pretty much on the right track.

It is indeed a laboratory-coined term, with strong traces of "oxygen" in it, and denotes a resin so tough and adhesive that new uses are being added almost daily to the impressive list of chores it already does. Depending on how you manipulate it, it will put a rugged protection on your car, stop leaks in radiators, keep the vital instruments in a missile from harm, hold together jet planes, or pave floors.

Just to indicate how versatile the resin is, it is predicted that this year, about 40,000,000 lb. will be used. In two years, a few visionaries say, that figure will be up tenfold. Most prophets, however, guardedly will settle for a handsome 100,000,000 lb. in 1961.

Today the big news in epoxy resins is that chemists are on the threshold of licking discoloration.

To appreciate the importance of this, you have to take a backward look at a decade of developments.

Basically, epoxies are made from natural gas plus liquefied petroleum gas (the kind many farmers cook with) and oxygen. Along the way, a triangular arrangement of atoms results (2 carbon, 1 oxygen) which, in extremely loose language, has a remarkable chemical affinity for whatever it contacts. So ardent is this bond that almost nothing can dissolve it.

Naturally enough, the first major use for epoxy resins was in coatings, that is in paints and varnishes. And to this day, coatings account for 70% of the output. (Varnishes alone take 14,000,000 lb.).

But there has been one drawback. Ultraviolet rays turn the coatings brown. So in fields requiring high eye-appeal, such as finishes for autos and boats, the epoxy resins had to remain in hiding as primers.

Now it looks as though a solution is in sight (Union Carbide Chemicals, for instance, has a promising product called Epoxide-201). If everything turns out as expected, sedans and schooners will have their epoxies outside where they will count most. Sales, of course, should soar accordingly.

Aside from their adhesive qualities, particularly the way in which they cling to metals, the epoxy resins won't shrink and they have great chemical resistance. An epoxy finish will stand up under detergents, alcohol, household cleaners, and just about anything else you could douse it with.

In plastic (solid) form, the epoxies show the same noteworthy features; moreover, they can take high temperatures quite well.

What happens to the 30% of the epoxy resins that aren't used in coatings? Here is today's breakdown:

- Reinforced plastics: (generally laminated glass fibers).
- Tooling: Epoxies make cheap and accurate dies.
- Adhesives; principally as replacements for rivets or solder, in missiles and aircraft. In this area, too, the do-it-yourself handyman will find a roster of "plastic metals" and "plastic steels" to shore up broken chairs, dented fenders, and for similar repair jobs. Although this ultimate consumer use doesn't amount to much in vol-

ume, it nonetheless has provided the epoxies with their most glamorous public appeal.

• Encapsulation of electronic parts in missiles so that they can withstand jarring. In all, there is a robust potential in the electrical-electronic fields, for the epoxies are flame-retardant, water-repellent, and transfer heat readily.

• Piping for chemical plants and oil field service. Thus a portion of the dream material winds up right where it was born, at a well.

"Free" Fuel for Spaceships

➤ Spaceships some day may "cruise almost indefinitely on free space fuel."

This was described in a Report of the House Committee on Science and Astronautics as "perhaps the most imaginative idea of all" concerning present and future space propulsion methods.

It would involve charting and using plasma or energy belts found in space. Such an energy belt exists around the earth, the Van Allen radiation belt, named after the Iowa State College physicist who discovered it. Data on the Van Rllen belts have been gathered by instruments in several Explorer satellites.

"By judicious navigation from one such energy belt to another, it may some day be possible to cruise almost indefinitely on free space fuel," the Committee report said.

But such an idea lies outside the two categories into which the Committee classified space propulsion programs. The first grouping, achievable in five years, included improving the chemistry of liquid and solid propellants. Theoretically, the energy-carrying capacity of these fuels can be upgraded 50%, the Committee said.

The second grouping, in which the "problem" will be defined in about five years and solutions may begin to appear in 10, includes harnessing nuclear and electric power. A less-conventional propulsion system might use free radicals — highly reactive parts of broken molecules.

The report described the development of Saturn, a liquid-fueled booster to have 1,500,000 pounds of thrust. Saturn is an Advanced Research Projects Agency project.

Somewhat further off in time, the report said, is the National Aeronautics and Space Administration's development of a single-chamber liquid-fueled rocket of up to 1,500,000 pounds thrust. These might be clustered to achieve 6,000,000 pounds thrust.

The report listed as needed for the future: (1) ways to recover and reuse large rocket engines that have been jettisoned, and (2) development of upper-stage liquid rocket engines using high-energy propellants, such as liquid oxygen and liquid hydrogen, or storable propellants.

By substituting high energy upper stages for those now used, payload increases of two to 10 times may be achieved, the report said.

The Committee called upon the Advanced Research Projects Agency (ARPA) for a decision soon on how man is to go to the moon. "It is possible," the report said, "that the first manned flights to the moon, and later to other planets in our solar system, will originate from space platforms already in earth orbits some 300 nautical miles above the earth.

Progress Made in H-Bomb Control

➤ A CONTROLLED thermonuclear reaction in the laboratory is believed to have been obtained for a tiny fraction of a second by scientists at the Naval Research Laboratory in Washington, D. C.

They hope to verify their harnessing of the forces released in nuclear fusion within a year, using a larger device they estimate will cost some $20,000,000 to build. With the present small device, the heart of the apparatus is only 12 inches long, they report a major step toward using thermonuclear processes for controlled production of power.

While Dr. Alan C. Kolb of NRL reported his research findings with the "high density magnetic mirror machine" at the Fourth International Conference on Ionization Phenomena in Gases at Uppsala, Sweden, his colleague, Dr. W. R. Faust, explained implications of the research at a news conference in Washington.

Dr. Faust said the experiments had shown three important new developments:

1. The gas, known as a plasma, was contained for a long time relative to the time required for normal thermal distribution to occur.

2. The length of time during which neutrons, neutral particles produced during thermonuclear fusion, are emitted is in agreement with theoretical calculations of plasma physics.

3. The plasma is observed to be stable during the approximately ten microseconds (millionths of a second) in which neutrons are observed.

The experiments were part of a high temperature physics program jointly financed by the Navy and the Atomic Energy Commission, to the tune of about $1,500,000 during the past three years.

If present findings are confirmed an important milestone has been reached in the process of obtaining useful power from the virtually unlimited supply of energy locked in the nuclei of deuterium, which is available in all the world's waters.

Dr. Kolb's approach is to compress deuterium preheated by a shock wave using an extremely high magnetic field. Energy released from an internal magnetic field and further magnetic compression bring the temperature up to its final value. Comparison between magnetic pressure and gas pressure indicates that the temperature is the order of 20,000,000 degrees absolute. This temperature is consistent with that necessary to produce the observed neutron yield by thermonuclear reactions.

NH_4NO_3 — Explosive Fertilizer

➤ AMMONIUM NITRATE, generally harmless and an excellent fertilizer, not only blasted out eight city blocks of Roseburg, Ore., but also was responsible for three of the five greatest accidental explosions of the past.

The white solid substance has such peculiar detonation properties that it was not recognized as an explosive for centuries. In fact, in its relatively pure form, it is almost impossible to explode.

Only recently, it has been found that when mixed with fuel oil, ammonium nitrate becomes extremely sensitive to heat and shock. Its explosive power sometimes equals that of TNT. In the past two or three years, because it is cheaper than dynamite, the ammonium nitrate-fuel oil mixture has become quite popular as a useful explosive.

Victor E. Haninger, an Interstate Commerce Commission explosives expert, explains that two of the more important safety precautions for storage of ammonium nitrate are:

(1) Do not keep it in unventilated confinement. A build-up of heat and pressure in a container could cause an explosion similar to that in the Texas City disaster 12 years ago.

(2) Store it away from sources of fire and other explosives.

A full report on the Roseburg disaster has not yet been made. An explosives-laden truck, parked near a building that caught fire, blew up. The truck was carrying ammonium nitrate and dynamite. It is not known what exploded first, something in the building, the dynamite, or the nitrate.

The Texas City explosion originated in the hold of the ship Grandcamp, possibly due to a lighted cigarette butt. The hold, loaded with millions of pounds of ammonium nitrate fertilizer, was closed while the fire smoldered.

Upon discovery of the burning nitrate bags, the ship's crew attempted to smother the flames with steam. Water might have ruined some of the cargo. Steam served only to make the hold hotter, and the nitrate blew up. A second ship exploded the following day, adding to the catastrophe that almost totally destroyed the city and killed more than 560 persons.

In the same year as the Texas City disaster, 1947, a ship also loaded with ammonium nitrate fertilizer exploded at Brest, France. Twenty-one deaths resulted, and major destruction spread over a three-mile area.

The worst of the ammonium nitrate explosions took place in 1921 at Oppau, Germany. About 9,000,000 pounds of the substance blew up. The blast left a lake one-third of a mile in diameter where a warehouse and a nitrate plant had been. Major damage covered an area of four miles. Some 1,000 persons died.

Detecting Water In Jet Fuels

➤ A SIMPLE "pill" treatment now can be prescribed for detecting minute traces of water in jet fuels.

The treatment, known as *Hydrokit,* is a quick and reliable way to make last-minute checks during fueling operations at an airport. Key to the treatment is a chemical powder that changes color in the presence of microscopic amounts of water. The powder, contained in capsule-type "pills," has been extensively field tested at major international airports.

Spot checks during fueling are the last in a long line of safeguards for insuring that jet fuels are almost completely free of tiny droplets of water. Careful handling of the fuels from refinery to airport, plus passing the fuels through filter-separator units, are two other precautions.

Jet fuels must be exceptionally wa-

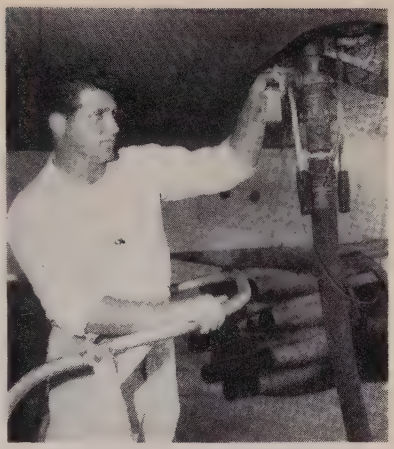
ter-free since big jet airliners fly at high altitudes where low temperatures could cause icing problems in fuel systems. A typical source of minute traces of water in petroleum fuels is condensation in storage tanks.

The instructions for making a test with the new Esso Research Center method are simple:

Draw off about a fifth of a pint of fuel from the fueling nozzle while servicing an aircraft. Empty the contents of a capsule-type "pill" into the bottle containing the sample. Cap the bottle and shake for 10 seconds.

Inspect the powder after it has settled. If no trace of pink or purple appears, the fuel has passed the test. Any sign of pink or purple spots indicates an undesirable amount of undissolved water.

The test is extremely sensitive. The gray powder will change color within one minute of contacting fuel containing 30 parts per million or more of dispersed water. That's about a thimble full of water in several hundred gallons of fuel. The test is made when fueling starts and can be repeated several times during the course of fueling.



➤ MECHANIC BEGINS *inspection of a sample of jet fuel during field test of a new method for detecting minute traces of water in jet fuels. The test, one of many, is being made under the wing of an intercontinental jet airliner at New York International Airport.*

A chemical powder that will change color in the presence of microscopic amounts of water has been added to the sample. Here, the powder is beginning to settle after brisk shaking of the bottle.

Sapphires Brewed in "Pressure Cooker"

➤ WHITE SAPPHIRES, more nearly perfect than Mother Nature's, are being brewed in a "pressure cooker," at the Bell Telephone Laboratories in Murray Hill, N. J.

To cook a batch of gems, some "seed" sapphires are heated under pressure in an autoclave with aluminum oxide and a water solution of washing soda. The heat and high pressure dissolve the aluminum oxide and cause it to grow onto the seeds.

Natural sapphires take thousands of years to grow, but these man-made ones are ready within a month.

The gems, free of strain, have many industrial uses. Bell Laboratories are using the sapphires in research projects aimed at improving telephony and communications in general.

Terylene Bonded to Rubber

➤ After five years of research, Canadian Industries Limited has discovered a new system of bonding polyester fibre to rubber, a development which may have world-wide implications in the manufacture of tires, industrial V-belts, automotive fan belts, conveyor belting, and other mechanical goods. The announcement was made by B. J. Moriarty, general manager of the company division which manufactures "Terylene" polyester fibre.

"This Canadian research achievement means that "Terylene", with its exceptional strength and dimensional stability, can now be used as readily as other fibres in the mechanical rubber goods field," Mr. Moriarty said.

The new system is much cheaper and more efficient than those in current use for bonding "Terylene" to rubber. Methods used with other fibres such as cotton, rayon and nylon are not effective with polyester fibre. Instead, it has until now been necessary to use bonding materials which are comparatively expensive and which are difficult to use because of their inflammability and toxic ingredients.

"Even with this handicap," Mr Moriarty said, "a substantial amoun of "Terylene" has already been use in mechanical rubber goods because i stretches very little, is exceedingly strong, and has high resistance to de terioration by oils and acids."

Five years ago C-I-L, at its centra research laboratory at McMasterville Que., undertook an intensive research program into the bonding problem The recent success is the result. Mr Moriarty said that in the past few months tests made in co-operation with Canadian rubber companies have confirmed the C-I-L laboratory findings. The new bond is so strong that in many cases, the rubber itself gave way in tests before the bond would break.

Apart from the bonding research program, C-I-L has been conducting intensive investigation into tire cord properties. Recently Firestone Tire and Rubber Company of Akron, Ohio, with which C-I-L has been co-operating closely, announced that "Terylene" had been found to be "equal or superior to any fabrics now used in premium tires in the United States."

Rocks and Pottery by New Method

➤ A radical new technique for measuring the age of prehistoric rocks, pottery, ceramics, and lava flows has been developed by Dr. George C. Kennedy of the University of California, Los Angeles.

The technique, based on heating a previously fired object and measuring its light glow, can now give approximate dates to objects up to 500,000 years old, and the range may eventually be extended to 2,000,000 years.

Dr. Kennedy explains his method by analyzing a piece of lava rock found on the coast of Alaska.

When the rock is heated to a temperature of about 800 degrees Fahrenheit under a sensitive photomultiplier vacuum tube, the heat releases a light called the thermoluminescent glow.

By taking the rock's total glow and mean radioactivity, both easily measured, Dr. Kennedy fixes the number of years since the rock was last heated. Basically, his formula reads: Age of rock equals glow divided by mean radioactivity.

In the example, he found that the Alaska lava must have come from a volcano which erupted 200,000 years ago.

The glow technique gives archaeologists another highly effective tool in addition to the carbon-14 "atomic time clock" method developed by Dr. Willard F. Libby of UCLA, which dates organic matter up to 25,000 years old.

A hobby led 39-year-old Dr. Kennedy, one of the country's leading experts on volcanoes, to the dating technique.

While investigating volcanoes in Mexico, he became fascinated with the small fired terra cotta figures and effigies buried in Indian graves of pre-Columbian times.

He gradually built up a collection, now considered one of the finest in the United States. As both a curious and a practical scientist, Dr. Kennedy began to wonder about the exact ages of his figures, and, not finding the information anywhere else, decided to develop his own answers.

Dr. Kennedy will check and refine his technique by measuring pottery from sites in Mexico, Greece, and the Near East, and comparing his results with the already established dates.

On the Back Cover

➤ Our back cover *shows the Fisher Roll-Around Vacuum System, a recent product of Fisher Scientific Co., Pittsburgh, Pa.*

This compact unit will produce any desired moderate vacuum (250 mm down to 0.5 mm Hg) anywhere that there is a 115 volt, 60 cycle A.C. outlet. It uses a ½ h.p., two-stage Welch Duo-Seal vacuum pump, and pump down is speeded up by large valve openings and connections.

Rough adjustments are made with a needle-valve and fine adjustments are made with a special mercury regulator mounted on top of the unit next to a sensitive manometer and a cold trap. The regulator consists of a glass tube of mercury forming an electrical contact. The level of the mercury in the tube is varied by tilting the tube. The vacuum pump runs continuously, holding down the pressure in one of a pair of steel ballast tanks. So long as the pressure in the system to be evacuated remains below the present pressure, the mercury contact in the regulator is maintained, and a solenoid valve between the tank and the system is closed. When the pressure rises in the system, the contact is broken, and the valve is opened.

According to Fisher releases, the advantages of this pump are that there is no intermittent surge of current since the pump is running continuously, and since it is mostly running against the evacuated tank, there is very little air passing through the oil and oxidizing it. Spring mounting of the pump minimizes vibration, and casters make it easy to move about.

Such a unit should prove useful in laboratories whose requirements do not justify the installation of a vacuum line.

Proudly Presented

This feature, now reintroduced after a three year lapse, will be devoted to announcements of new commercial products, industrial news, and newly available literature.

➤ SCHWARTZ Laboratories, Inc., of Mount Vernon, New York, has now made available Dehydrated Firefly Tails for research in bioluminescence. Prices range from $7.50 for 2 grams to $150.00 for 50 grams.

➤ CHEMETRON Corporation's Cardox Division is constructing a plant near Philadelphia that it says will be the largest carbon dioxide producing facility in the Northeast and one of the largest in the U. S. to recover carbon dioxide from ammonia.

Roy T. Omundson, Cardox Division president, said in Chicago that the plant being built at Gibbstown, N. J., about 15 miles southwest of Philadelphia, will have a production capacity of 155 tons of liquid and solid carbon dioxide a day. Raw material will be obtained from a nearby E. I. duPont de Nemours & Company ammonia plant.

The output of the New Jersey plant will be distributed from Maine to Virginia in liquid and dry ice forms to various industries including beverage, food, transportation, foundry, rubber, paint, metals, aviation, welding and fire protection.

➤ FOR THE FIRST TIME, the plastics field will have access to a complete catalog of machinery and equipment with detailed, comparative specifications. The compilation is a feature of the new Modern Plastics Encyclopedia issue for 1960. Now entering its 21st year, the Encyclopedia is the only comprehensive standard reference book in the plastics field.

Bound in hard covers, Modern Plastics Encyclopedia has 1241 pages. It is cross-indexed for subject contents and advertisers, and includes bibliographies of books and periodicals in the field, as well as general industry statistics. It contains the most comprehensive listings of plastics materials services and machinery available.

Further information may be obtained from the publisher, Breskin Publications, Inc., 575 Madison Ave., New York 22, N. Y.

➤ GROUND WAS broken at Ludington, Michigan, in the latter part of October for what is believed to be the world's largest-capacity lime kiln.

The kiln will be built at the Ludington Division of The Dow Chemical Company adjacent to two other kilns already operated there by the company.

The kiln will be designed to produce approximately two tons of lime per day, well beyond the range of present-day lime kilns. This will almost double the capacity of Dow's present lime-producing facilities at Ludington and will be the first of the new Allis-Chalmers-Lepol type grate kilns devoted to lime production in the United States.

It is scheduled for completion by approximately August 15, 1960.

➤ Pure Carbonic Company and Wyle Manufacturing Corporation cooperating on a project to show the advantages of carbon dioxide (CO_2) liquid as a cooling agent for environmental testing have developed a traveling exhibit mounted on a 40-foot flatbed trailer to demonstrate products directly at the plant sites of missile/aircraft components manufacturers.

The CO_2 liquid for the demonstrations is provided in two storage units: a stationary six-ton unit and a half-ton mobile unit. These units, typical of those made available by Pureco, provide storage without loss over an indefinite period.

Also included in the exhibit is a Wyle chamber which features self-contained temperature control and utilizes CO_2 liquid by direct injection into the chamber.

Manned by both Wyle and Pureco personnel, the exhibit will be in continuous use as a permanent demonstration. Initial showings, which will be in the Southern California and San Francisco Bay areas, have already been scheduled for sixty-five prime and subcontract manufacturers. Later, the exhibit will be used in other sections of the country.

➤ A new Test Paper, Hydrion Lo-Buff 5 - 9, providing a new order of sensitivity in pH test papers, is announced by R. P. Cargille Laboratories Inc., 117 Liberty Street, New York.

Heretofore an appreciable amount of buffer was required for Test Papers to indicate pH of aqueous solutions. This new Test Paper readily shows differences in pH between tap water and distilled water. It is recommended for use in the control of all treatment of water and for checking the pH of water used in fisheries, swimming pools and for all purposes where the water contains a very small amount of buffering agent.

The range of this Test Paper is pH 5.0 to 9.0 and the color chart shows the colors indicated by steps of 0.5 pH unit. Sample color chart will be sent on request. This Test Paper is furnished in rolls $\frac{3}{8}$ inch wide x 180 inches long, sufficient for over 200 tests.

➤ Capacity of Du Pont's plant for making methyl methacrylate monomer at Belle, W. Va., will be expanded by 40 per cent.

Methyl methacrylate is the chemical intermediate for a variety of acrylic plastics and coating resins made by Du Pont and its customers.

Because of outstanding weatherability, methacrylates are widely used to produce auto lacquers and household paints which retain their initial gloss and color values over an extended period without maintenance.

The increase is also planned to support markets for "Lucite" 147, a composition tailored for use in extrusion of flat sheet for the sign and lighting industry and "Lucite" acrylic sirup for lamination with fibrous mats in the production of reinforced plastics parts with superior weathering ability.

Methacrylate monomer is also used in the manufacture of cast sheet, resins for ink, and ingredients for protective lacquers for bright metals and plastic sheeting and in hot melt and heat seal adhesives.

Book Condensations

Source Book of the New Plastics — Herbert R. Simonds, Ed. — *Reinhold,* 354 p., illus., $10. Includes improvements in established materials, producers' new materials, federal-sponsored research and brief patent survey.

Organic Chemistry, An Outline: Problems and Answers — Corwin Hansch and George Helmkamp — *McGraw,* 258 p., paper, $2.95. Provides drill problems and answers for the beginning student.

International Directory of Radioisotopes, Vol. I: Unprocessed and Processed Radioisotope Preparations and Special Radiation Sources — *International Atomic Energy Agency (International Publications, N. Y.),* 277 p., paper, $3.50. First comprehensive world catalogue, with sources of supply, chemical form, prices and other details.

Mechanism and Structure in Organic Chemistry — Edwin S. Gould — *Holt,* 790 p., $12.50. Textbook devoted to the consideration of the mechanisms of homogeneous organic reactions, with descriptive chapters dealing with the structures of atoms and organic molecules.

Phenolic Resins—David F. Gould — *Reinhold,* 213 p., illus., $5.75. Survey of the properties and applications of phenolics, useful to the engineer, manufacturer and student.

Zinc: The Science and Technology of the Metal, its Alloys and Compounds — C. H. Mathewson, Ed., chapters by specialists — *Reinhold,* 721 p., illus., $19.50. Definitive monograph on the metallurgy, chemistry, extraction and uses of zinc, prepared in cooperation with the American Zinc Institute.

Organic Chemistry: A Brief Course — Ray Q. Brewster and William E. McEwen — *Prentice-Hall,* 2nd ed., 401 p., illus., $10. Completely revised textbook for one-semester course.

Gas Chromatography — A. I. M. Keulemans, C. G. Vervier, Ed., foreword by A. J. P. Martin — *Reinhold,* 2nd ed., 234 p., illus., $7.50. Gives chemists an up-to-date account of the practical and theoretical aspects of this rapidly developing analytical tool.

Comprehensive Analytical Chemistry, Vol. 1A: Classical Analysis — Cecil L. Wilson and David W. Wilson, Eds. — *Elsevier (Van Nostrand),* 577 p., illus., $5. Deals with introductory and general material of importance in any branch of analytical chemistry, with processes of such long standing that they are usually referred to as classical analysis.

Treatise on Analytical Chemistry, Part I: Theory and Practice, Vol. 1 — I. M. Kolthoff and Philip J. Elving, Eds., asstd. by Ernest B. Sandell — *Interscience,* 809 p., illus., $17.50. Presents a concise, critical, comprehensive and systematic treatment of classical and modern analytical chemistry.

Thermodynamics and Statistical Thermodynamics — John Geldart Aston and James John Fritz—*Wiley,* 556 p., $8.25. One-year graduate course covering the new statistical methods used for calculating thermodynamic properties of ideally gaseous organic compounds.

Chemistry Comments

Continuing our teaser column of interesting facts in the chemical world.

➤ Great Britain is totally lacking in natural gas resources.

➤ Next to air, water is our most important resource for survival; you can live longer without food than you can without water.

➤ Natural gas today supplies about one-quarter of the total energy needs of the U. S. and Canada.

➤ Vanadium improves the toughness, mechanical properties and heat-treating characteristics of some steels often used in engine and motor parts.

➤ An average-size (six-ounce) sweet potato of any commercially important variety supplies more than twice the amount of vitamin A an adult needs daily.

➤ Concentrated iodine salts deposited at the base of the filament of an incandescent light bulb cause the bulb to burn without blacking and allow it to give an undiminished amount of light during its life.

➤ Diuretics are drugs that increase the body's excretion of water and salt, and are important in treatment of congestive heart failure, high blood pressure and kidney diseases.

➤ Tungsten's melting point of 6,170 degrees Fahrenheit is the highest of all metals.

➤ The color of the hair depends on the degree of melanin pigment present; total absence of melanin results in white hair.

➤ Man found out how to bombard the atomic nucleus and make radioisotopes artificially for most elements about 25 years ago.

➤ One of the problems of the space age is the development of materials that can withstand sudden and extreme temperature changes.

➤ Tritium, a radioactive isotope of hydrogen, is formed in the atmosphere by the action of cosmic rays and is also produced in large quantities by thermonuclear explosions.

➤ Tobacco smoke may contain as many as 400 different compounds.

➤ Present transistors employ germanium or silicon as the semiconducting element, and they are limited to maximum operating temperatures of about 190 to 450 degrees Fahrenheit.

➤ Silicon and germanium crystals are usually "grown" by slow crystallization of the melted compound onto a seed crystal.

➤ Tritium is a radioactive isotope of hydrogen, its mass being three times that of ordinary hydrogen.

➤ The first U. S. satellite experienced a temperature range from 218 degrees below zero Fahrenheit to 550 degrees above in its elliptical path around the earth.

➤ A radiation-resistant rubber has been developed that can be applied in the fabrication of pneumatic seals for nuclear reactors.

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